Sun Fire™ X4100 and X4200 Server Architectures

A Technical White Paper

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Introduction

The Sun Fire™ x64 servers are the fastest most reliable and energy efficient x64 enterprise servers in the industry. They are a family of modular, rack-mounted servers designed by Sun Microsystems from the ground up to take full advantage of the exceptional power and performance of AMD Opteron™ processors. The Sun Fire x64 server line is composed of the industry's premier x64 servers delivering highest reliability, and greater than one-and-a-half times the performance while providing $500 per year in power and cooling savings over comparable Intel Xeon based servers. These new Sun servers are based on a simplified management system and fast and reliable performance, resulting in better service levels, lower operational costs, and better asset utilization. The Sun Fire x64 family of servers feature x64 (x86 64-bit)
performance with 32-bit x86 compatibility, large memory support, I/O capability to support low-latency, high-bandwidth interconnects for compute clusters, Integrated Lights Out Management with in-band and out-of-band control, and a wide range of peripheral and ISV support. This is the only family of x64 industry-standard servers with application portability across the entire family through binary compatibility on Solaris™ , Linux, or Windows operating systems. Sun Fire X4100 and X4200 servers are primarily designed for customers running workloads such as Web and application services, IT infrastructure (DNS, proxy, caching), horizontally scalable databases, and high-performance technical computing (HPTC)/grid computing.

Figure Intro-1: Sun Fire X4100 and X4200 Servers

Customers seeking a business edge can look to Sun to provide smarter options for building a simple, secure, standardized IT infrastructure. The Sun Fire x64 family of servers are smart solution enablers for standardizing the datacenter -- a high-performance set of servers that offer the unity of vertical scaling with the economies of horizontal scaling, while running any major OS and 32-bit/64-bit application. Sun continues its efforts to provide customers with solutions to help them realize the benefits of a horizontal infrastructure (lower incremental CPU cost, OS flexibility) while reducing the hidden costs and complexities.

There are initially two members of the Sun Fire x64 family: Sun Fire X4100 (1RU) and Sun Fire X4200 (2RU). These servers are the first in a new line of Sun x64 servers designed to improve the economics of x64 systems while setting new standards for performance, reliability, and energy efficiency by reducing cost and complexity while delivering Sun's rock-solid enterprise-class capabilities and quality. Both are high-performance, single- or dual-socket platforms with single- or dual-core processors in a 1RU or 2RU package. Both use the same hot-swappable power supplies, hot-swappable hard disk drives, CPUs, memory, and Service Processor. The use of common components across the entire

server line requires fewer spare parts on hand, lowering operational costs. Table 1-1 shows the maximum configurations supported by each server.

Table 1-1: Sun Fire X4100 and X4200 Maximum Configurations

	Sun Fire X4100	**Sun Fire X4200**
# of sockets supported	2	2
# of memory slots	8 DIMMS (4 slots per CPU)	
Maximum memory	32 GB using 4 GB DIMMS	
# of hard disks supported	2 disks + DVD OR 4 disks with no DVD	4 disks + DVD
# of PCI-X slots	2	5

Sun Fire X4100 and X4200 servers feature redundant, hot-swappable fan modules and redundant, hot-pluggable AC power supplies to enable increased availibility and simplified serviceability. Both systems support a consistent I/O feature set that includes four (4) 10/100/1000BaseT Gigabit Ethernet ports, a four-channel SAS RAID 0/1 disk controller with integrated mirroring, video, USB ports (Sun Fire X4100: one front, two rear and Sun Fire X4200: two front, two rear), and a dedicated serial and 10/100BaseT Ethernet remote management port. For further expansion, the Sun Fire X4100 provides two (2) low-profile PCI-X slots and the Sun Fire X4200 provides five (5) low-profile PCI-X slots for high-performance application I/O. Single- and dual-core AMD Opteron CPUs are supported to provide a flexible, high-performance growth path and investment protection – 32-bit applications are protected while still enabling seamless migration to 64-bit applications.

The Sun Fire x64 server family also includes an extensive set of RAS (Reliability, Availability, and Serviceability) features which reduce hidden serviceability costs by dramatically simplifying system maintenance. In addition, the Sun Fire x64 family of servers provides remote lights out server management, including remote keyboard, video, mouse, and storage (RKVMS); remote boot; and remote software upgrades using the Integrated Lights Out Manager (ILOM) Service Processor.

Chapter 1

Architecture Overview

Sun Fire X4100 Server

The Sun Fire X4100 server measures 1 rack-unit (RU) high (or 1.72 inches/43.8 mm) 17.5 inches (445 mm) wide, and 25.2 inches (640 mm) deep. It is a rack-optimized, x64-based system with a symmetric multiprocessor. Cooling is accomplished with internal fans that direct airflow from the front to the back of the chassis. I/O ports are located on the rear panel, with an additional USB on the front panel. Access to the power connections is at the rear of the server. Hard drives and optical storage are accessible from the front of the server.

The Sun Fire X4100 server also provides the following system architecture features:

- Embedded single-channel DDR memory controllers on each CPU to provide maximum memory capacity and bandwidth scaling delivering up to 16 GB of capacity and 12.8 GB/sec. of aggregated bandwidth with 2 CPUs populated and 4 GB DIMMs. (3-4x faster than typical x86 servers that use the Intel Northbridge architecture)
- AMD Direct Connect Architecture that directly connects CPU-to-CPU with Coherent HyperTransport™ links delivering 8 GB/sec. aggregate bandwidth per link, CPU-to-I/O with non-Coherent HyperTransport links delivering 4.8 GB/sec. aggregate bandwidth per link, CPU-to-memory using the integrated DDR controller, and CPU cores to each other on the same die in dual-core processors
- Two PCI-X slots to deliver high-performance I/O with over 1.5 GB/sec. of I/O plug-in bandwidth
- Embedded quad Gigabit Ethernet and a SAS disk controller to leave the two PCI slots available for expansion needs
- Embedded management and legacy I/O to offer maximum operational flexibility without compromising PCI-X slots for optional features

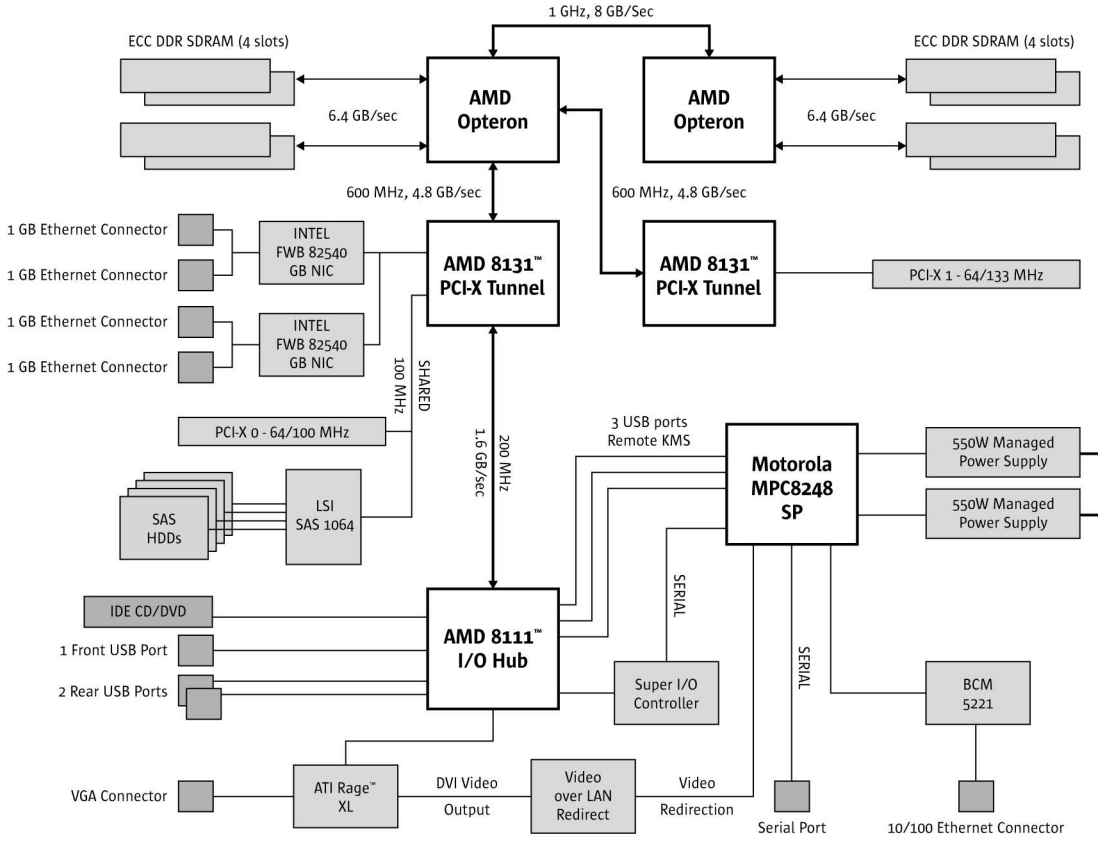

Figure 1-1: Sun Fire X4100 Server Architecture Block Diagram.

Sun Fire X4200 Server

The Sun Fire X4200 measures 2 rack-unit (RU) high (or 3.449 inches/87.6 mm), 17.5 inches (445 mm) wide, and 25.2 inches (640 mm) deep. It is a rack-optimized, x64-based system with a symmetric multiprocessor. Cooling is accomplished with internal fans which direct airflow from the front to the back of the chassis. I/O ports are located on the rear panel, with an additional two USB on the front panel. Access to the power connection is at the rear of the server. Hard drives and optical storage are accessible from the front of the server.

The Sun Fire X4200 server also provides following system architectural features:

- Embedded single channel DDR memory controllers on each CPU to provide maximum memory capacity and bandwidth scaling delivering up to 32 GB of capacity and 12.8 GB/sec. of aggregated bandwidth with 2 CPUs populated and 4 GB DIMMs. (3-4x faster than typical x86 servers that use the Intel Northbridge architecture)
- Direct Connect Architecture that directly connects CPU-to-CPU with Coherent HyperTransport links delivering 8 GB/sec. aggregate bandwidth per link, CPU-to-I/O with non-Coherent HyperTransport links delivering 4.8 GB/sec. aggregate bandwidth per link, CPU-to-memory using the integrated DDR controller, and CPU cores to each other

on the same die in Dual-core processors

- Five PCI-X slots deliver high-performance I/O, over 1.5 GB/sec. of I/O plug-in bandwidth.
- Embedded quad Gigabit Ethernet and a SAS disk controller to leave the five PCI slots available for expansion needs
- Embedded management and legacy I/O to offer maximum operational flexibility without compromising PCI-X slots for optional features

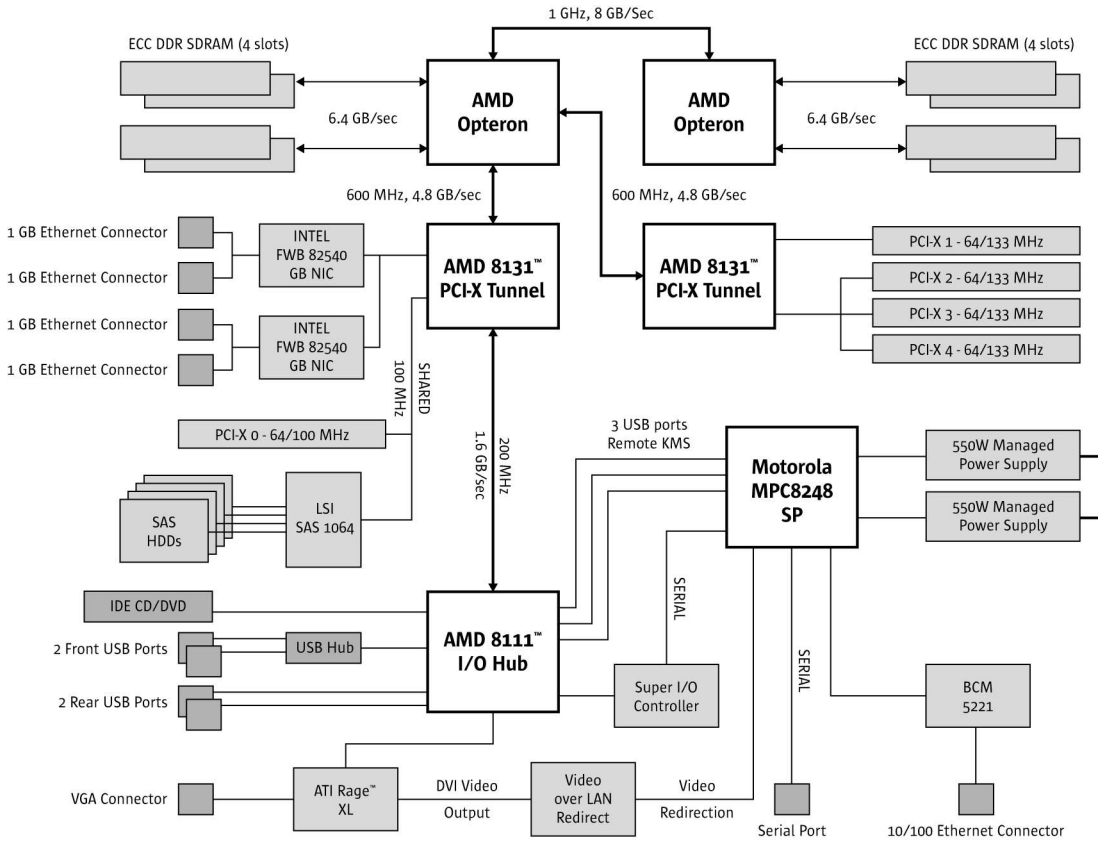

Figure 1-2: Sun Fire X4200 Server Architecture Block Diagram.

Chapter 2

CPU Architecture

The Sun Fire X4100 and X4200 servers support one boot and one optional Single-Core or Dual-Core AMD Opteron Series 200 processor. The base processor is inserted in physical position CPU0 (the right side socket on the motherboard when viewed from the front of the system). In a dual processor configuration, the CPUs must be of the same model/speed and stepping version.

Each processor contains an integrated memory controller supporting a 128-bit wide path to memory and three 16x16-bit HyperTransport links. Each HyperTransport link runs at speeds up to 1 GHz and is clocked on both edges of the clock pulse, allowing for a maximum of 4 GB/sec. (2 gigatransfers/sec., 2 bytes wide) throughput in each direction (8 GB/sec. aggregate data rate bidirectionally). Memory support is for registered DDR400 184-pin SDRAM DIMMs, four DIMM slots per CPU, accessed in pairs with an available memory bandwidth up to 6.4 GB/sec. (with PC3200) per processor. Memory capacity scales with the number of processors. Therefore, memory attached to an unpopulated processor socket is unaddressable. As a result, a single processor machine can support a maximum of four DIMMs. A dual CPU server supports a maximum of eight DIMMS or 32 GB (8 x 4 GB) of memory.

Note: 4 GB DIMM support is anticipated in 2006 to enable 16 GB of memory per CPU and a maximum memory configuration of 32 GB in a 2-CPU configuration. At release, 2 GB DIMMs will be the largest DIMMs supported, enabling a maximum memory configuration of 16 GB in a 2-CPU configuration.

AMD Opteron Processor

Features of the AMD Opteron processor in the Sun Fire X4100 and X4200 servers include:

- 1 or 2 Single-Core or Dual-Core AMD Opteron 200 Series processors
- x64 architecture (64-bit extensions) with AMD Direct Connect Architecture using HyperTransport Technology
- Native support for 32-bit x86 ISA, SSE, SSE2, MMX, and 3DNow!
- Three HyperTransport links supporting up to 8 GB/sec. of direct inter-processor bandwidth and up to 4.8 GB/sec. of bandwidth to PCI-X bridges
- ECC protection for L1 data cache, L2 unified cache, and DRAM with hardware scrubbing of all ECC protected arrays
- CPU L1 Instruction cache: 64KB 2-way associative, parity protected with advanced branch prediction
- CPU L1 Data cache: 64KB 2-way associative, ECC protected
- Two 64-bit operations per cycle, 3-cycle latency
- CPU L2 cache: 1MB 16-way associative, ECC protected
- Exclusive cache architecture storage, in addition to L1 caches
- 256 TB of memory address space

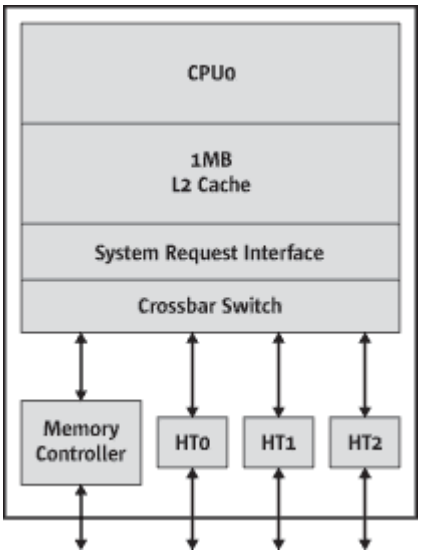

Figure 2-1: Single-Core AMD Opteron Processor Architecture

The Sun Fire X4100 and X4200 servers support both Single-Core and Dual-Core AMD Opteron 200 Series processors. From the start, AMD64 processors were designed to add a second core—the port already existed on the crossbar/SRI. Dual-core AMD Opteron processors have unique instances of L1 cache (I-cache and D-cache) and L2 cache for each CPU core. Features of the Dual-Core AMD Opteron processor include:

- Socket compatibility with existing 940-pin sockets that are compatible with 90nm single-core processor architectures
- One die with 2 CPU cores
- Same power requirements as single core CPUs
- Individual L1 Instruction cache per CPU core
- Individual L1 Data cache per CPU core
- Individual 1 MB L2 cache per CPU core
- Shared memory controller and HyperTransport interconnects for 2 cores
- Fully utilized memory and HyperTransport bandwidths

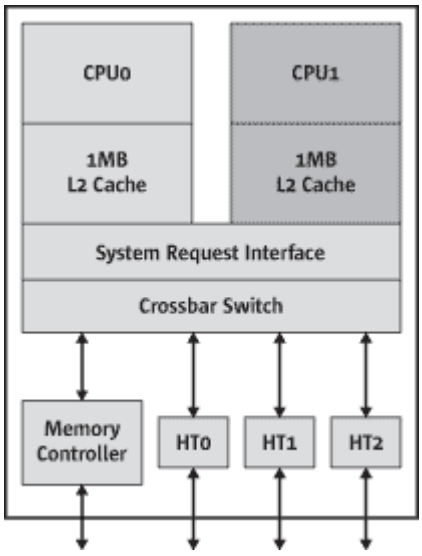

Figure 2-2: Dual-Core AMD Opteron Processor Architecture

Note: Sun Fire X4100 and X4200 servers support 95W and 120W 90nm technology package infrastructure AMD Opteron Rev E processors only.

CPU Packaging

AMD Opteron processor packaging specifications include:

- 940-pin lidded organic micro PGA
- 1.27 mm pin pitch
- 31 x 31 row pin array
- 40 mm x 40 mm organic substrate
- Organic C4 die attachment
- 16.5 mm x 11.3 mm die size

Processor VRM

Each processor receives core voltage input from an individual voltage regulator module (VRM). The VRMs regulate the system current and voltage according to the VID code output by the CPU package. The VRM is a DC-to-DC point of load convertor specified for +12 Volt input and programmable 100 Amp output.

Memory Architecture

Each CPU includes a low-latency, high-bandwidth, integrated memory controller that reduces latencies during memory access over traditional Intel front-side bus-based memory controllers. Up to four ECC Registered DDR400 memory modules per CPU are supported. The AMD Opteron processor's memory controller works in 64-bit or 128-bit mode ECC

operation. For best performance results, it is recommended to run 128-bit ECC operation mode. To run in 128-bit mode, DIMMs should be populated in pairs such that they occupy one-half of the AMD Opteron processor's 128-bit controller interface. The controller supports 1 bit per byte ECC, and supports DDR400 (PC3200) registered DDR SDRAM modules.

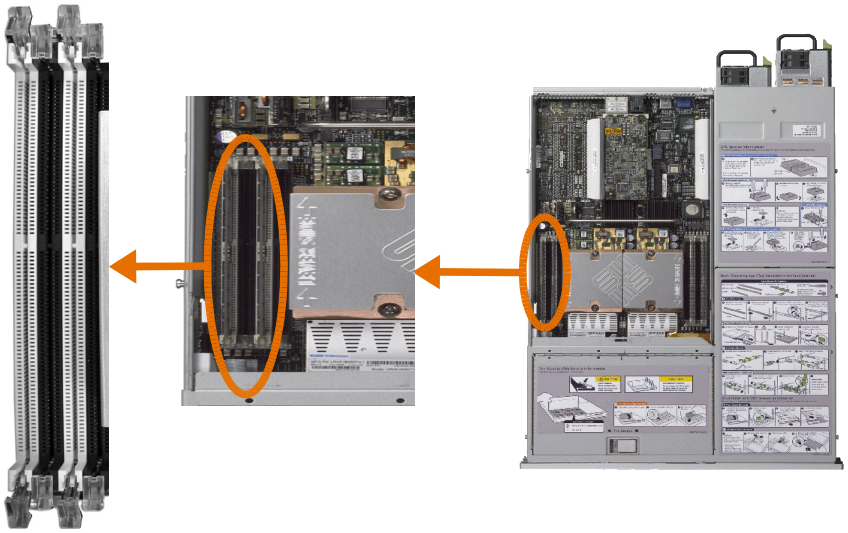

Figure 2-3: Sun Fire X4100 and X4200 Memory DIMM Slot

The Sun Fire X4100 and X4200 servers have 4 DDR DIMM slots per CPU that are color-coded white and black to indicate population order (white = 0,1 and black = 2,3; white pair first). LED fault indicators controlled by the ILOM Service Processor provide the ability to easily identify failed DIMM modules. Memory capacity scales with the number of processors. Therefore, memory attached to an unpopulated processor slot is unaddressable. As a result, a single processor machine can support a maximum of four DIMMs. A dual CPU server supports a maximum of eight DIMMS or 16 GB (8 x 2 GB) of memory.

Other features of the Sun Fire X4100 and X4200 servers memory architecture include:

- Dedicated on-die 128-bit wide DDR memory controller
- Memory bandwidth up to 6.4 GB/sec. @ DDR400
- Under 80 ns latency
- Registered ECC DDR400 (PC3200) supported
- 256 MB to 2 GB low profile (1.2 inch/3.05 cm) DIMM support
- Up to 16 GB per CPU in with 4 GB DIMMs in 4 DIMM slots per CPU
- Single supply (2.50 VDC)
- Standard SPD (VCC-SPD=3.3V)

Note: The 32-bit version of Red Hat Enterprise Linux 3.0 is not capable of using more than 4 GB of physical memory, even if more

than 4 GB is installed. This is a limitation of the default kernel, not the hardware.

x64 Architecture

The x64 architecture is an x86-compatible architecture that enables simultaneous 32-and 64-bit computing. It enables end users to run their existing installed base of 32-bit applications and operating systems at peak performance, while providing a migration path that is 64-bit capable. It is designed to enable 64-bit computing while remaining compatible with the vast x86 software infrastructure. x64 architecture represents a new class of computing, enabling a single architecture across 32- and 64-bit environments.

The x64 Instruction Set Architecture (ISA) extends the existing x86 ISA and natively executes 32-bit code with no emulation mode to degrade performance. For 32-bit software that does not require immediate 64-bit implementations, x64 processor-based systems are designed to provide full application performance while continuing to improve with x64 platform performance enhancements.

Many applications encounter architectural barriers that prevent efficient performance scaling. The x64 ISA is designed to allow continued performance scaling for applications that demand multiprocessor scalability, larger addressable memory, better multimedia performance, or improvements in computational accuracy.

The x64 ISA has been designed for applications that:

- Need large memory addressing to handle datasets larger then 3 GB per process (financial and scientific modeling applications)
- Must manage a large number of concurrent users or application threads, such as large-scale, thin-client solutions, large databases, data warehouse applications for solutions in customer relationship management (CRM), supply chain management (SCM), enterprise resource planning (ERP), and digital rights management (DRM) systems
- Require real-time encryption and decryption for enhanced security, including e-commerce and protection of private or classified data
- Require mathematical precision and floating-point performance, including modeling, simulation, statistics and financial analysis, imaging/video/signal processing, physics, medical research, telecommunications, encryption, and compression
- Require large, high-power database performance, including decision support, searching and indexing, document and content management, and voice recognition
- Require x86 compatibility or the economies of scale of x86 as well as the large memory addressing capabilities of 64-bit computing, including many high-performance computing (HPC) cluster applications
- Provide digital content creation capabilities such as computer-aided design (CAD), computer-aided manufacturing (CAM), and computer-aided engineering (CAE), digital music production and video editing, and real-time media streaming solutions
- Require maximum performance for realistic and cinematic consumer experiences, including computer games, digital video, and real-time collaboration.

x64 processors are designed to maintain full compatibility with x86 while providing the architectural enhancements that provide world-class 64-bit performance. With the x64 ISA, relevant instructions and encodings have evolved to support 64-bits, increasing the resources available to hardware and software. Major enhancements over legacy x86 include:

- Sixteen 64-bit general-purpose integer registers that quadruple the general purpose register space available to applications and device drivers as compared to x86 systems
- Sixteen 128-bit XMM registers for enhanced multimedia performance to double the register space of any current SSE/SSE2 implementation
- Full 64-bit virtual address space with 40 bits of physical memory addressing that can support systems with up to 4 petabytes of physical memory—65535 times the amount of RAM supported by 32-bit x86 systems
- 64 -bit operating systems to provide full, transparent, and simultaneous 32-bit and 64-bit platform application multitasking

x64 processors include HyperTransport Technology and are designed for flexibility and scalability. HyperTransport Technology provides links-based multiprocessing, simplifying the design of multiprocessor workstations and servers. Compatibility with x86 makes the x64 computing platform the first 64-bit platform designed to be compatible with mainstream PC applications while offering world-class performance, making it suitable for solutions ranging from consumer client PCs to high-performance clusters. The combination of flexibility and scalability reconciles the broad range of capability and performance requirements IT professionals face today.

AMD Direct Connect Architecture

AMD Direct Connect Architecture helps eliminate the bottlenecks inherent in a front-side bus by directly connecting the processors, the memory controller, and the I/O to the CPU to enable overall system performance and efficiency. Directly connected CPUs provide more linear, symmetrical multiprocessing. A memory controller directly connected to a CPU optimizes memory performance. I/O directly connected to a CPU provides more balanced throughput and performance. Dual-core processors extend the benefits of the AMD Direct Connect Architecture by connecting two CPU cores to each other on one die to reduce latencies between those cores.

HyperTransport™ Technology

HyperTransport™ Technology is a high-speed, high-performance, point- to-point link for directly connecting integrated circuits. HyperTransport Technology also directly connects the I/O to the processors at a rate of 4.8 GB/sec. Aggregate bandwidth per link, enabling a peak bandwidth of 24 GB/sec. per processor. The AMD Opteron processor with HyperTransport Technology provides a scalable direct connection between processors, I/O subsystems, and other chipsets. HyperTransport technology helps reduce the number of buses in a system, which can reduce system bottlenecks and enable today's faster microprocessors to use system memory more efficiently in high-end multiprocessor systems.

Memory Interface

In traditional x86 Northbridge/Southbridge architectures, processors share a memory controller and are not directly connected to one another. Memory transactions must propogate through the Northbridge chip fabric. This presents a bottleneck at the front-side bus that greatly reduces productivity and performance potential. In a Direct Connect Architecture, each CPU has its own integrated memory controller, which allows for more linear, symmetrical multiprocessing and optimized memory performance. This direct connection to the memory controller significantly reduces the memory latency seen by the processor. Latency will continue to drop as the processor frequency scales.

Additionally, hardware and software memory pre-fetching mechanisms can further reduce the effective memory latency seen by the processor. This reduction in memory latency, coupled with the additional increase in memory bandwidth available directly to the processor (resulting from this platform architecture design optimization), is critical as it greatly enhances system performance across all application segments.

Chip-to-Chip Interconnect

Current interface schemes offer throughput performance on the order of 266 MB/sec. to 1 GB/sec. Although these rates may be sufficient for desktop platforms, workstation, server, and other future platforms require a more robust interface. The simultaneous integration of high-speed technologies (such as Gigabit Ethernet, PCI-X, and the InfiniBand Architecture) onto high-end platforms will quickly dwarf the bandwidth capabilities of existing interfaces. Direct Connect Architecture using HyperTransport Technology provides a high-speed, chip- to-chip interconnect that virtually eliminates the I/O performance bottleneck while providing ample performance headroom for future growth.

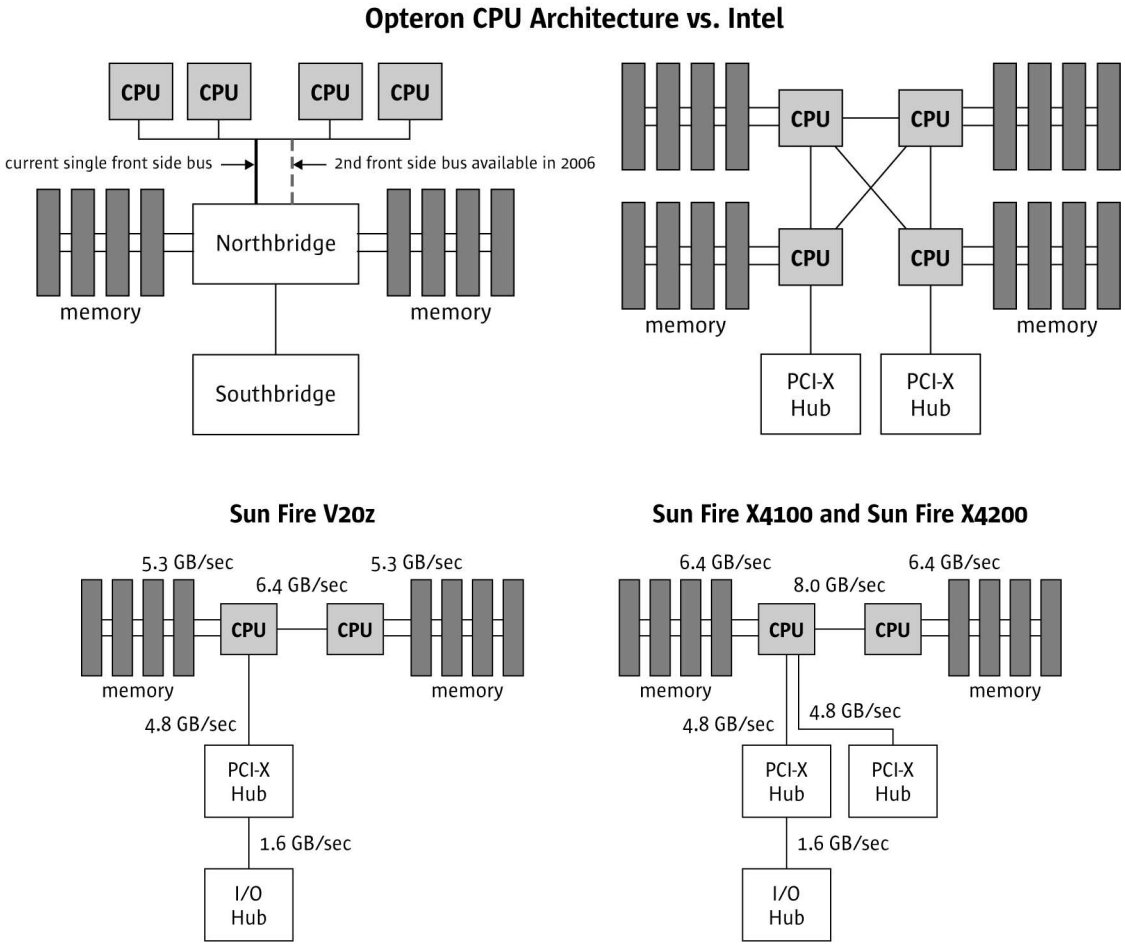

Figure 2-4: Intel vs. Opteron Architectures

I/O Expansion Capability to High-Speed Industry Buses

The traditional Northbridge/Southbridge architecture is not intended to support more than two core-logic elements. Adding additional high-speed functionality (such as Gigabit Ethernet, PCI-X, the InfiniBand Architecture, or any combination thereof) would have to occur in one of three ways:

- The functionality would have to be attached to an existing bus interface such as the PCI bus. However, an existing bus may not have sufficient bandwidth to support high-speed technologies, especially in instances in which multiple buses or combinations of buses must be supported simultaneously.
- The functionality would have to be directly attached to the higher speed proprietary chip-to-chip interconnect bus via a bridging device. However, the proprietary nature of this solution may limit the number of components available from vendors, thus impacting cost and availability.

- The functionality would have to be integrated into one of the core logic components. This solution is the least flexible, as a wide range of components would have to be created for each desired combination of feature-set buses.

HyperTransport Technology, an industry standard, provides system designers a high-speed, daisy-chained interconnect between system components. Specific components can be connected in a building-block fashion to achieve a platform with specific feature-set and performance objectives. Figure 2-5 shows a sample HyperTransport technology architecture block diagram.

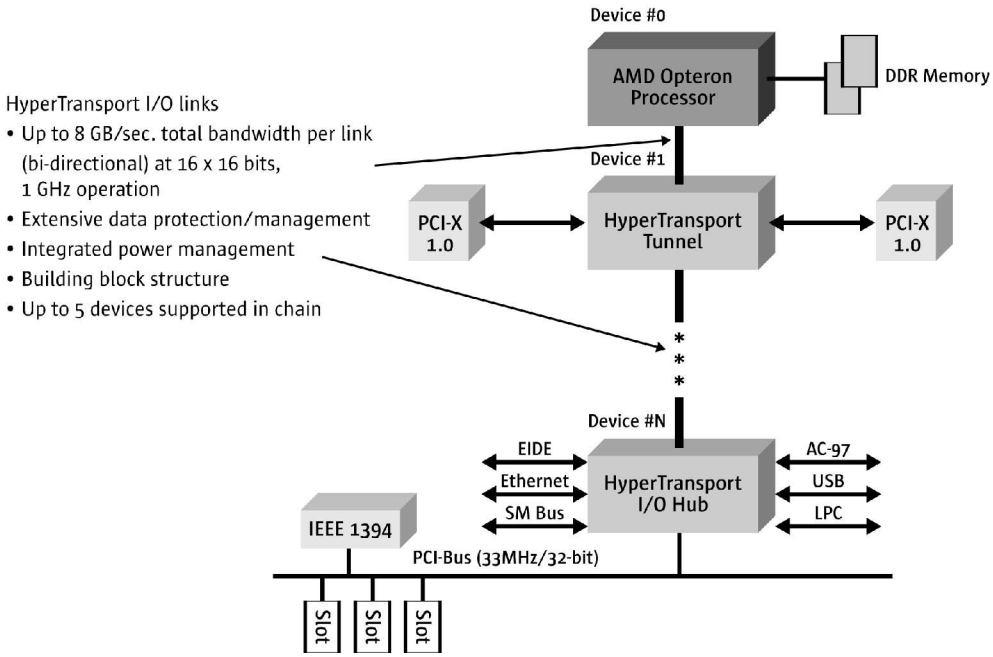

Figure 2-5: Sample HyperTransport Technology Architecture Block Diagram

Chapter 3

I/O Subsystem

Sun Fire X4100 and X4200 I/O Subsystem Overview

The Sun Fire X4100 and X4200 I/O subsystem is connected to the CPU complex through a HyperTransport link from the boot processor. The I/O subsystem consists of the following components:

- Two tunneling HyperTransport bridges (AMD-8131 HyperTransport PCI-X Tunnels)
- A HyperTransport attached Southbridge component (AMD-8111 HyperTransport I/O Hub)
- Flash memory for the BIOS
- Additional motherboard embedded peripheral I/O consisting of:
    - One quad channel SAS RAID controller (LSI SAS1064) attached to one of the AMD-8131 PCI-X Tunnels on a shared bus with the PCI-X slot 0.
    - Two 10/100/1000 dual Gigabit Ethernet MAC/PHY devices (Intel FW82546 GB NIC)
    - A video controller device attached to the PCI bus of the Southbridge (ATI Rage XL)
    - A Super I/O device connecting the Service Processor to the AMD-8111 chip

AMD 8000 Series Chipset

The AMD 8000 series chipset consists of:

- HyperTransport interconnects (previously discussed)
- AMD-8131™ HyperTransport PCI-X Tunnel
- AMD-8111™ HyperTransport I/O Hub

AMD-8131™ HyperTransport PCI-X Tunnel

The AMD-8131 HyperTransport PCI-X Tunnel chip includes two 64-bit PCI-X bridges, bridge A and bridge B. Each independently supports conventional PCI mode with clock speeds of 33 and 66 MHz, or PCI-X mode with clock speeds of 66, 100, and 133 MHz. Each supports 64-bit addressing in PCI-X or PCI 2.2 and a 64-bit data bus. Each includes an IOAPIC register set for legacy interrupt modes. The upstream bi-directional HyperTransport tunnel link supports receive and transmit frequencies of up to 600 MHz of 16-bits. The downstream bi-directional HyperTransport tunnel link supports receive and transmit frequencies of up to 200 MHz of 8-bits. These links also support independent transfer rates and bit width selection.

The AMD-8131 HyperTransport PCI-X Tunnel provides high-speed PCI-X capability and offers the following features:

- Two HyperTransport PCI-X bridges supporting 64-bit 33, 66, 100, and 133 MHz operation
- 4.8 GB/sec. maximum bandwidth 16 x 16 600 MHz upstream HyperTransport link
- 1.6 GB/sec. maximum bandwidth 8 x 8 200 MHz downstream HyperTransport link
- 37.5 x 37.5 mm, 829-pin BGA package
- 3.3 volt PCI-X signaling; 1.2 volt link signaling; 1.8 volt core

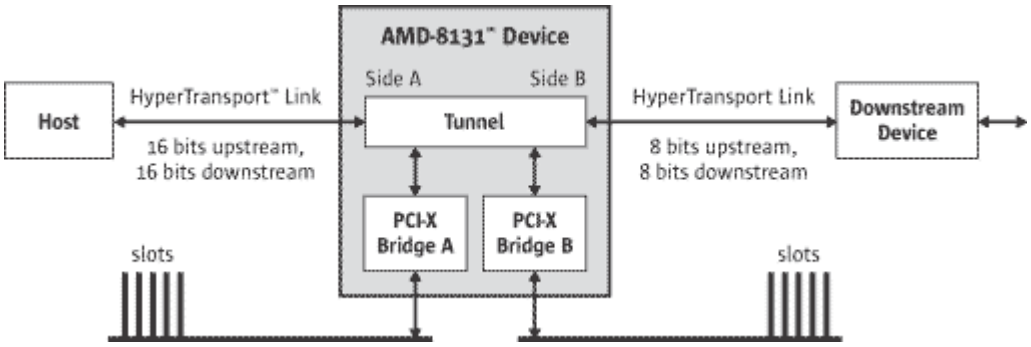

Figure 3-1: AMD-8131 HyperTransport PCI-X Tunnel Architecture Block Diagram

AMD-8111™ HyperTransport I/O Hub

The AMD-8111 HyperTransport I/O Hub is a HyperTransport attached Southbridge device that provides several I/O blocks supporting basic peripherals and support functions to the system. It supports total bandwidth up to 800 MB/sec., using 8-bit HyperTransport input and output links running simultaneously with a 200 MHz (double pumped) clock. Multiple bit widths, including eight bits, four bits, and two bits (input and output) are supported.

The AMD-8111 HyperTransport I/O Hub provides integrated system I/O and peripheral support and offers the following features:

- 8-bit 200-MHz upstream HyperTransport link
- 10/100 Ethernet MAC (not used)
- Dual EIDE CD-ROM controller (only one is used)
- AC'97 audio (not used)
- Six USB 1.1 ports (3 connected to SP for virtualized remote keyboard, mouse, and storage, 3 used for I/O)
- PC I/O functions (RTC, CMOS, PIT, DMAC, and port control)
- IOAPIC register
- PCI 32/33 interface (8 arbiters) used for the ATI Rage XL video
- Low pin count (LPC) legacy bus
- SMBus 1.0 and 2.0 controllers
- ACPI register set and support logic
- 35 x 35 mm, 492-Pin BGA package
- 1.8-V Core; 3.3-V Output Drivers; 5-V Tolerant Input Buffers

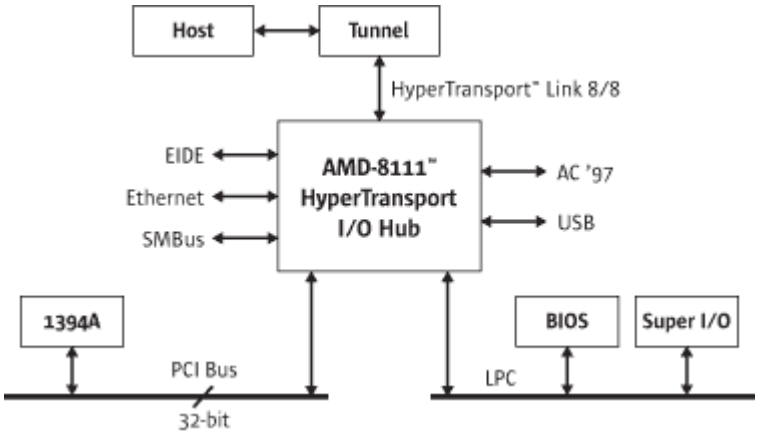

Figure 3-2: AMD-8111 HyperTransport PCI-X Tunnel Architecture Block Diagram

LSI SAS1064 SAS Controller

Sun Fire X4100 and X4200 servers include an integrated LSI SAS1064 4-port 3 Gbits/sec. SAS HW RAID disk controller. The LSI SAS1064 is a versatile controller that provides 4 SAS ports capable of 3.0 Gbits/sec. data transfers for each phys, for a total maximum bandwidth of 12.0 Gbits/sec.

SAS features of the LSI SAS1064 include:

- Four fully independent phys
- Support for 3.0 Gbits/sec. SAS data transfers for each phys
- High-performance, serial, point-to-point, enterprise-level storage interface
- Simplified cabling between devices
- Data transfers using SCSI information units
- 133 MHz 64-bit PCI-X interface (shared bus with PCI-X 0 100 MHz slot)
- Integrated RAID solution provides Integrated Mirroring technology and Integrated Striping technology

Although the LSI SAS1064 controller is capable of supporting both SAS and SATA drive types, the Sun Fire X4100 and X4200 servers will only support SAS hard disk drives.

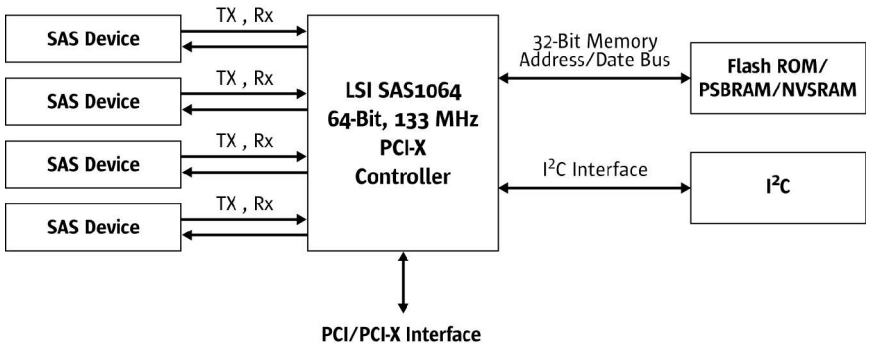

Figure 3-3: LSI SAS1064 Architecture Block Diagram

Intel 82546EB Dual Port Gigabit Ethernet Controllers

Sun Fire X4100 and X4200 servers are equipped with two Intel 82546EB Dual Port Gigabit Ethernet controllers that provide quad Gigabit ethernet interfaces to the server platform. These servers are the first x64 rack-optimized servers available with four on-board Gigabit Ethernet ports for reducing network complexity. The Intel 82546EB Dual Port Gigabit Ethernet controller provides two 64-bit fully integrated Gigabit Ethernet Media Access Control (MAC) and physical layer (PHY) functions. It is capable of transmitting and receiving data at 10/100/1000 Mb/sec. data rate with half or full duplex capability. Additional features of the Intel 82546EB Dual Port Gigabit Ethernet controller include:

- 802.3ab PHY compliance and compatibility (CAT-5 use)
- 802.3ab auto-negotiation
- 802.3x full-duplex flow control
- 802.9q VLAN tag insertion, stripping, and packet filtering
- Preboot eXecution Environment (PXE) Flash Interface support (32- and 64-bit)

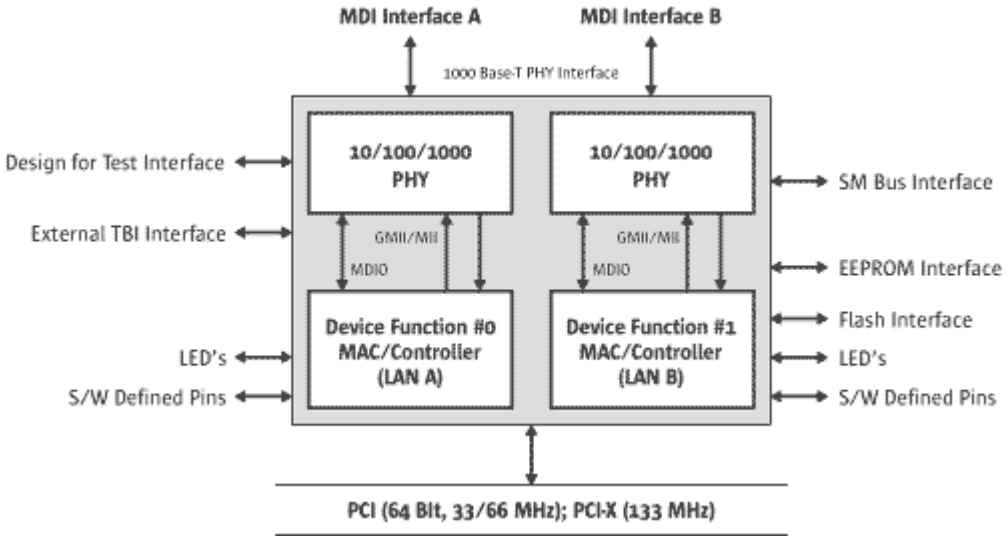

Figure 3-4: Intel 82546EB Dual Port Gigabit Ethernet Controller Architecture Block Diagram

ATI Rage™ XL Video

The Sun Fire X4100 and X4200 servers use the ATI Rage™ XL graphics controller to deliver 2D and 3D graphics acceleration. The DVI port is connected to the service processor for remote graphics redirection. The ATI Rage XL has the following features:

64-bit 125 MHz memory clock

- 8 MB external memory
- 64-bit SDR (SDRAM/SGRAM) memory path
- 64-bit AGP/PCI bus
- Integrated TMDS: DVI, DFP and VESA P&D interface
- Support for 24bit TTL
- 1600x1200 maximum resolution
- 16.7M maximum color depth
- 1024x768 TMDS

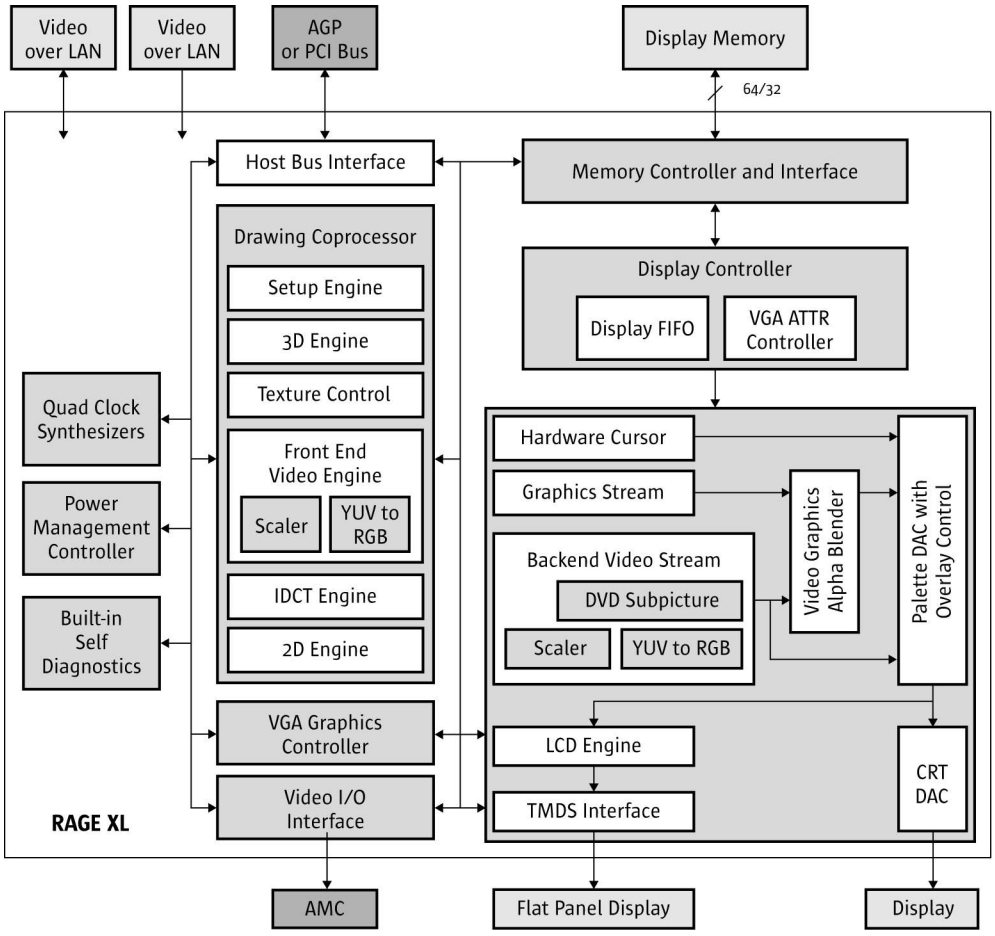

Figure 3-5: ATI Rage XL Architecture Block Diagram

SMSC LPC47B272 Super I/O Controller

The Super I/O device offers multiple I/O functions required to provide legacy I/O devices to the operating environment. On the Sun Fire X4100 and X4200 servers, it provides the following:

- Floppy disk
- Serial port connection between SP and AMD-8111

PCI-X Expansion Slots

The PCI slots on the Sun Fire X4100 and X4200 servers use a 3.3 Volt signaling bus. Therefore, they support only 3.3 Volt keyed MD2 expansion cards. The use of 5 Volt keyed expansion cards is unsupported and will result in damage to the motherboard.

There are 2 defined card lengths for low profile PCI expansion cards, MD1 and MD2. MD1 defines the shortest 32-bit card length available, 4.721 inches (119.91 mm). MD2 defines the maximum length of low profile PCI card available, 6.600 inches (167.64 mm). Any low profile PCI card that is longer that the MD1 definition but shorter that the MD2 definition is considered to be MD2 form factor. The two card lengths enable system designers to support either all low profile PCI cards, which includes MD1 and MD2, or limit their design to support only MD1 cards.

Sun Fire X4100 Server PCI Expansion Slots

The Sun Fire X4100 server has 2 PCI-X expansion slots. When viewing the server from the rear, PCI 0 is the lefthand slot and PCI 1 is the righthand slot. Both slots are capable of 32- or 64-bit operation and support low profile MD2 PCI or PCI-X expansion cards.

PCI 0 is on a shared bus with the LSI SAS1064 disk controller connecting to the AMD-8131 PCI-X Tunnel. This slot has a maximum operational speed of 100 MHz. It is important to note that if an expansion card that operates at speeds less than 100 MHz is inserted into this slot, then the transfer speed along the entire bus will be degraded. As a result embedded disk performance can be affected. Since the shared bus speed will be lowered to the lowest common denominator, the performance degradation will be greater if using a 33 MHz expansion card than a 66 MHz expansion card. For best disk performance results, the PCI 0 slot should not be populated. However, is there is a need to use it, then PCI 0 should only be populated with a 100 MHz expansion card.

PCI 1 is on a non-shared bus and has a maximum operational speed of 133 MHz. It supports both 33 and 66 MHz PCI expansion cards and 66, 100, and 133 MHz PCI-X expansion cards.

Sun Fire X4200 Server PCI Expansion Slots

The Sun Fire X4200 server has 5 PCI-X expansion slots. When viewing the server from the rear, the PCI slots are present in numeric order from left to right and numbered from 0 to 4. All 5 slots are capable of 32- or 64-bit operation and support low profile MD2 PCI or PCI-X expansion slots.

PCI 0 is identical to that in the Sun Fire X4100 server. PCI 0 is on a shared bus with the LSI SAS1064 disk controller connecting to the AMD-8131 PCI-X Tunnel. This slot has a maximum operational speed of 100 MHz. It is important to note that if an expansion card that operates at speeds less than 100 MHz is inserted into this slot, then the transfer speed along the entire bus will be degraded. As a result embedded disk performance can be affected. Since the shared bus speed will be lowered to the lowest common denominator, the performance degradation will be greater if using a 33 MHz expansion card than a 66 MHz expansion card. For best disk performance results, the PCI 0 slot should not be populated. However, is there is a need to use it, then PCI 0 should only be populated with a 100 MHz expansion card.

PCI 1 is identical to that in the Sun Fire X4100 server. PCI 1 is on a non-shared bus and has a maximum operational speed of 133 MHz. It supports both 33 and 66 MHz PCI expansion cards and 66, 100, and 133 MHz PCI-X expansion cards. PCI 2, PCI 3, and PCI 4 are on a shared bus with each other. Each expansion slot has a maximum operational speed of 66 MHz. These slots support both 33 and 66 MHz PCI expansion cards and 66 MHz PCI-X expansion cards.

Chapter 4

Motherboard

All control and datapath functionality, with the exception of the disk connectors, reside on the motherboard. There are two sockets for AMD Opteron processors, interconnected through AMD's HyperTransport™ technology. There are also HyperTransport links to the PCI-X bridges and the Southbridge. All external connections, with the exception of power, disks, and front panel I/O, come into the motherboard.

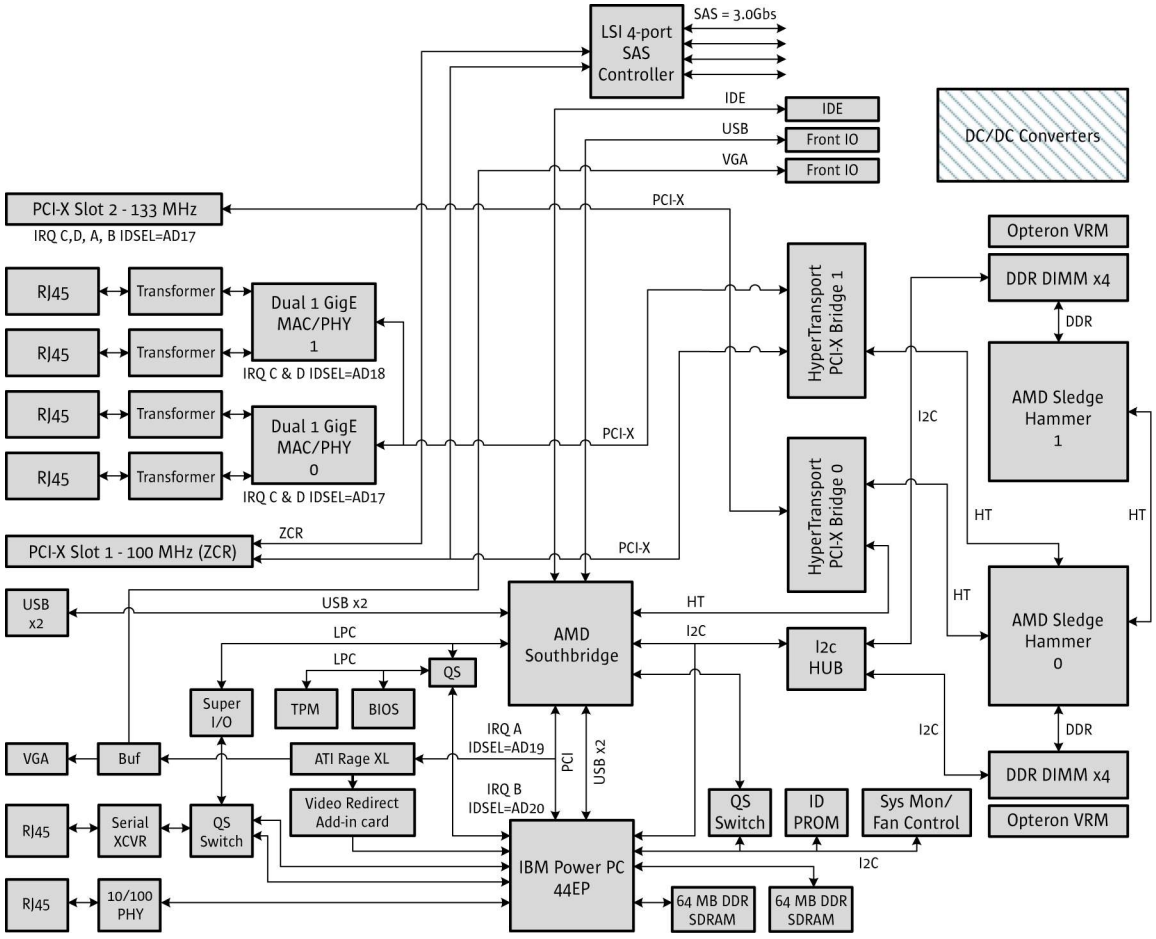

Figure 4-1: Sun Fire X4100 Motherboard Block Diagram

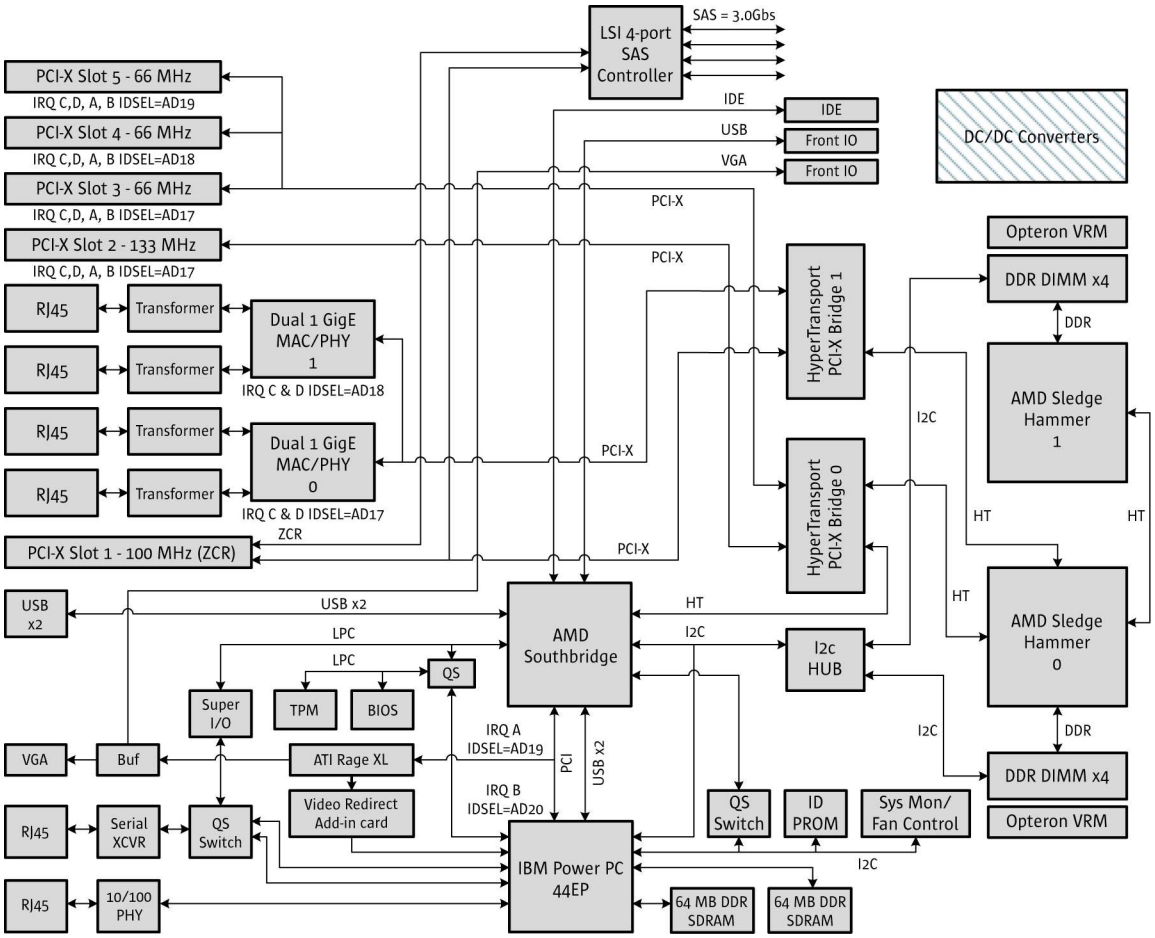

Figure 4-2: Sun Fire X4200 Motherboard Block Diagram

Chapter 5

Cooling and Power

Typical heat dissipation and power consumption metrics for a Sun Fire X4100 or X4200 server equipped with 2 Dual-core AMD Opteron processors and 4 GB RAM are as follows:

- UL Maximum Power: 800 W
- Typical Power Consumption: 450 W
- Heat Dissipation: 1500 BTU/hr
- Ambient Temperature: 5-35 C

Cooling

The chassis of the Sun Fire X4100 and X4200 servers are segregated by an air divider into two distinct chambers: the motherboard/PCI and fan chamber and the Power Supply Unit (PSU) and storage chamber. Both areas are front-to-back air cooled. The PSU and storage chamber is cooled by individual fans on the back of each power supply. Air is drawn through the front of the server by these rear-located fans. The motherboard/PCI and fan chamber is cooled by redundant rows of fans mounted in front of the server behind the bezel.

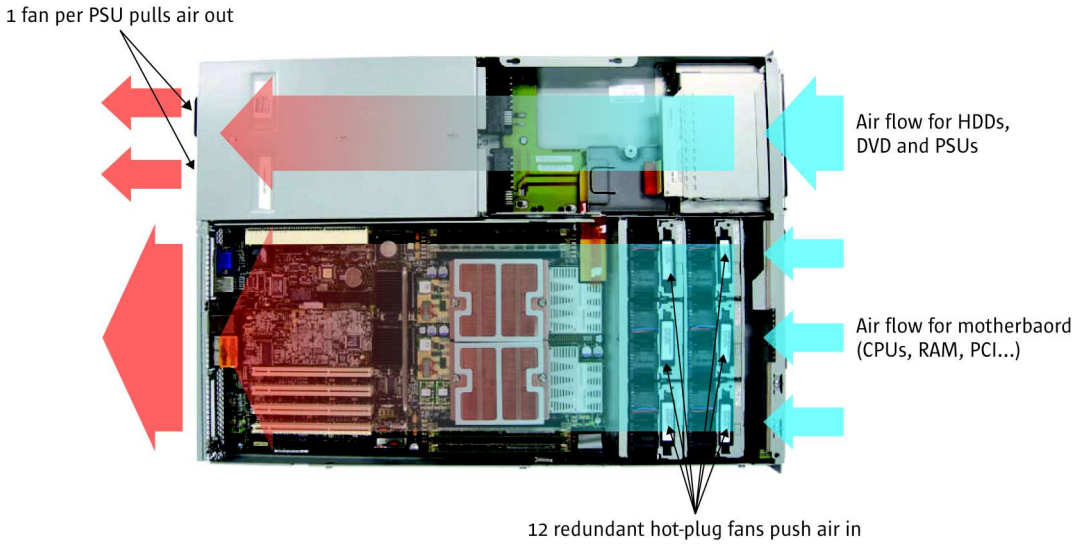
1 fan per PSU pulls air out
Air flow for HDDs,
DVD and PSUs
Air flow for motherbaord
(CPUs, RAM, PCI...)
12 redundant hot-plug fans push air in

Figure 5-1: Airflow Diagram of Sun Fire X4100 and X4200 Servers

Fans

Cooling fans in the Sun Fire X4100 and X4200 servers are positioned in two rows for redundancy just behind the front bezel. They are hot swappable and each fan module has an LED fault indicator. The fans are accessible from the top hinged hatch door in the front left side of the server, when facing the server from the front. This enables the fans to be accessed without interrupting system operation. Additionally, it makes it possible to service fans by only partially removing the server from the rack, allowing all cabling to remain in place.

Fan speed is modulated by the Service Processor with Pulse Width Modulation by an ADM 1026 sensor chip. All fans are controlled with the same PWM frequency so they all operate at the same speed. The ADM 1026 device uses readings from 3 sensors to control the fan speed: Front Panel Ambient Temperature, CPU 0 Die Temperature, CPU 1 Die Temperature. The Service Processor reads the fan speeds and turns the fan fault LED on if the RPM is under a threshold.

The fan modules in Sun Fire X4100 and X4200 differ from each other. The layout, however, is very similar in both servers. In the front of the motherboard compartment, beneath the hinged hatch door, there are 2 redundant rows of fan trays. Each row of fan trays is occupied by 3 fan modules. In a Sun Fire X4100 server, the fan modules are populated by pairs of 40 mm, 15,000 RPM Delta TFB0412EHN fans. In a Sun Fire X4200 server, the fan modules are populated by single 80 mm, 7,500 RPM Delta FFB0812UHE fans. The Sun Fire X4100 server contains a total of 12 cooling fans and the Sun Fire X4200 server contains a total of 6 cooling fans.

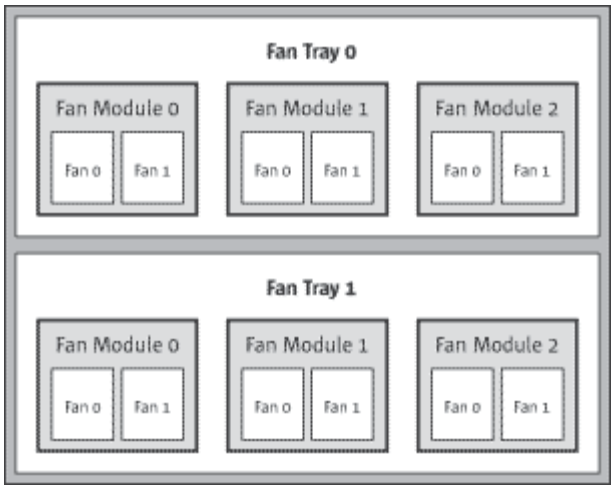

Figure 5-2: Sun Fire X4100 Server Cooling Fan Layout

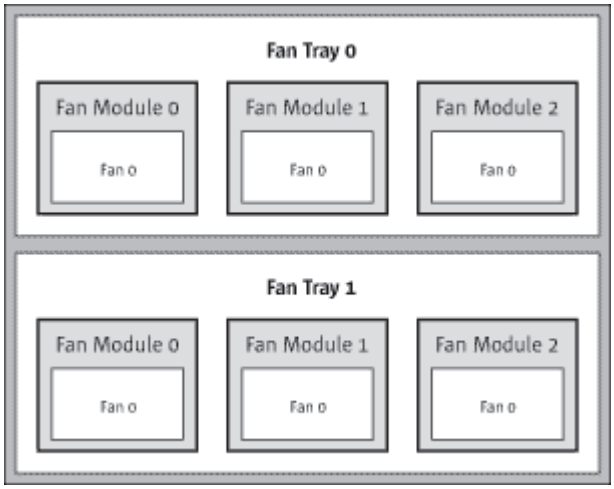

Figure 5-3: Sun Fire X4200 Server Cooling Fan Layout

Power Supplies

Sun Fire X4100 and X4200 servers are powered by dual redundant hot-swappable power supplies.

The power supplies have the following features:

- 550 Watts
- 120/240 Volt – 50/60 Hz Autodetect
- 1 40 mm fan in rear
- Power sharing

Chapter 6

ILOM: Integrated Lights Out Management

Integrated Lights Out Management (ILOM) is the Service Processor. ILOM enables multiple in-band and out-of-band management solutions. In-band management through the host operating system, or platform, is enabled by IPMI and SNMP OS-resident agents. Out-of-band management is enabled through the serial port or dedicated Ethernet. There is a command line interface (CLI) provided when out-of-band serial port conenctivity is used. The dedicated Ethernet connectivity to out-of-band management features includes:

- Web interface
- CLI via SSH
- IPMI 2.0
- SNMP v1, v2c, and v3

ILOM Architecture

The Sun Fire X4100 and X4200 servers leverage the same ILOM design and part. ILOM is a Sun-designed Field Replaceable Unit (FRU) daughtercard. The ILOM daughtercard has the following features:

- Motorola MPC8248 PowerPC processor
- 32-bit 266 MHz
- 16 Kb 4-way associative data cache
- 16 Kb 4-way associative instruction cache
- 64-bit data bus
- 66 MHz PCI bridge
- 64 MB PC-133 MHz SDRAM
- 16-bit 32 MB Flash ROM
- DVI output
- USB connections to AMD-8111 I/O Hub
- LPC (Low Pin Count) connection to AMD-8111 I/O Hub
- 10/100 Mb Integrated LAN
- 3 serial ports (Debug, RS485, external)
- Half-size standard PCI form factor

The ILOM daughtercard is a standalone system with no dependencies on the operating system. It has availability to physical interfaces through the connections listed above. The actual devices, however, are located on the main system board. The DVI output port is connected to the ATI Rage XL via FPGA to enable remote graphics redirection from ILOM with a maximum VGA resolution of 1024 x 768. Three USB connections to the AMD-8111 I/O Hub are used to provide remote keyboard, mouse, and storage functionality. There is an LPC connection to the AMD-8111 I/O Hub via FPGA. The 10/100 Mb Ethernet is connected to the onboard Broadcom BCM5221 10/100 Ethernet controller which automatically

detects straight or cross-over Ethernet cables. The external serial port is multiplexed with the main system serial port for access to the ILOM CLI and system console using serial port redirection (S-o-L Serial-over-LAN).

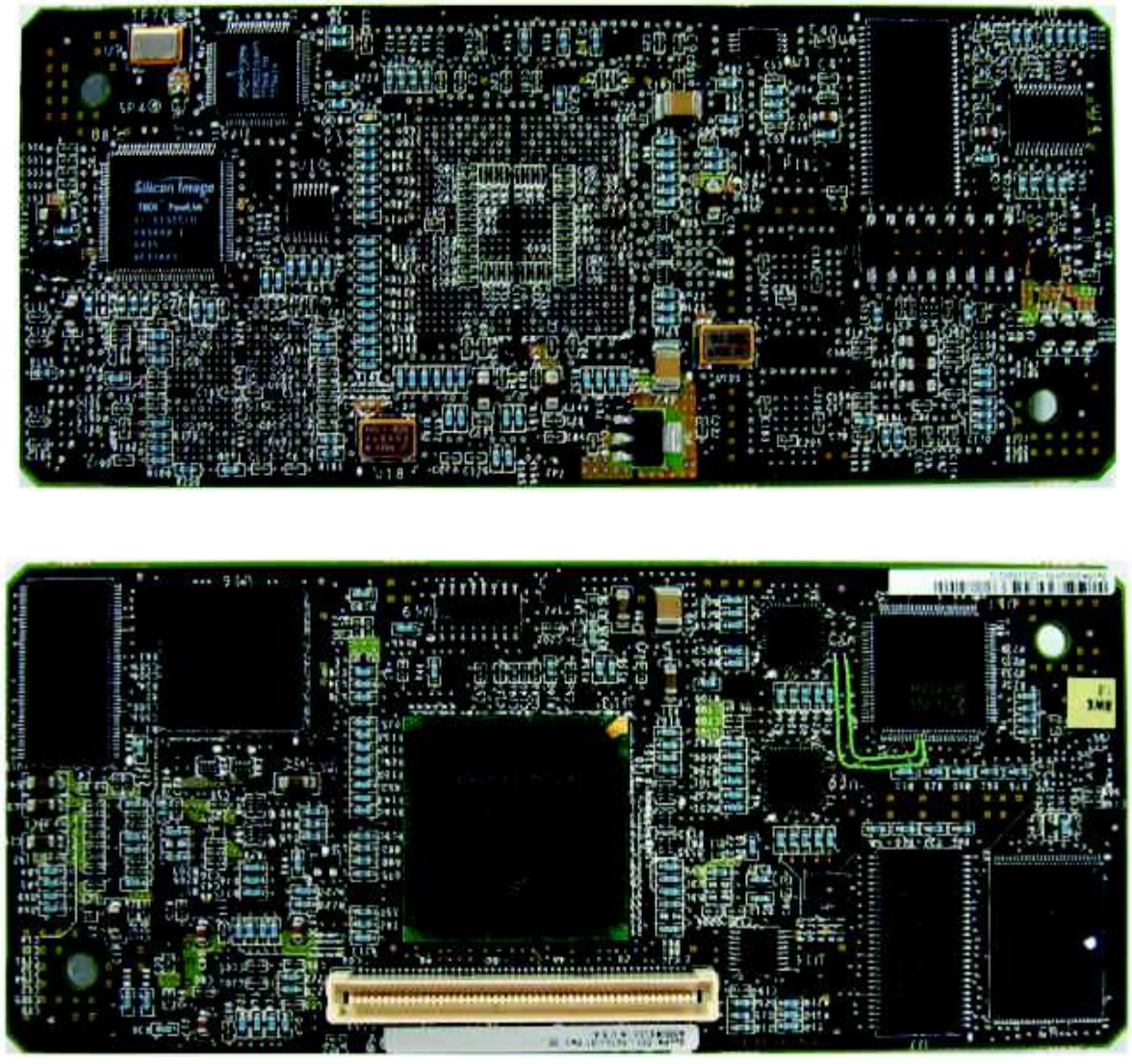

Figure 6-1: ILOM Daughtercard—Top and Bottom Views

ILOM Software

ILOM is an IPMI 2.0-compliant Baseboard Management Controller (BMC) which implements Lights Out Management (LOM) including “Remote Keyboard, Video, Mouse, and Storage” (KVMS), a Web management interface, a command line interface (CLI) and SNMP. ILOM software includes the following:

- Embedded, hardened Linux OS
- IPMI 2.0 BMC
- Platform Control agents diagnostics software
- RKVMS

The ILOM and BIOS firmware are easily upgraded using a single 11 Mb file to upgrade both. The firmware upgrade can be performed either by command line interface or Web interface.

In-Band Server Management Interfaces

Server management through the platform operating system in a Sun Fire X4100 or X4200 server is possible using either IPMI with a Keyboard Controller Style (KCS) inteface and an IPMI kernel driver or by using SNMP OS-resident agents. IPMI 2.0 and SNMP v1, v2c, and v3 are the supported standards to perform autonomous platform management functions.

Baseboard Management Controller (BMC)

ILOM and its controlling firmware are together referred to as the Base Management Controller (BMC), which is the core of the IPMI structure. Tightly integrating an IPMI BMC and management software with platform firmware facilitates a total management solution.

Out-of-Band Server Management Interfaces

Server management through the ILOM service processor in a Sun Fire X4100 or X4200 server is possible through serial port access or dedicated Ethernet connection. Serial port connectivity to ILOM provides direct console access to the command line interface (CLI)and to the system console stream via serial port redirection, i.e., serial-over-LAN. The dedicated Ethernet interface offers ILOM connectivity by Web interface, CLI via SSH, IPMI 2.0, and SNMP v1, v2c, and v3.

Command Line Interface (CLI)

The ILOM command line interface is accessible either by connection to the serial port or the dedicated Ethernet connection via Secure Shell (SSH) on a Sun Fire X4100 or X4200 server. The CLI is designed to follow the Distributed Management Task Force (DMTF) Command Line Protocol (CLP).

The DMTF CLP is based on these concepts:

- Object namespace—There is a large namespace of objects to describe the targets for each command. Examples of

objects are a CLI user, an SNMP trap, or an alert rule.

- Command verbs—There are a small number of command verbs that operate on those objects. Command verbs are simple and include create, delete, set, show, start, and stop, for example.
- Object properties—An object may have one or more properties, or parameters. For example, a user ID object has a password and roles properties.
- Options—A command may have options that modify or clarify its operation. The DMTF CLP lists several options that must be supported by all commands.

The syntax of an ILOM command is

```
<verb> <options> <target> <properties>
```

Not all commands require options, a target, or properties to be specified.

The core of the model for the DMTF CLP is a hierarchical objects namespace where an object in the namespace is a target to a command. There are two namespaces that an SP can reference: its own namespace whose root is /SP, and the overall system namespace whose root is /SYS. The purpose of the /SP namespace is to represent configuration and state for the SP. The primary purpose of the /SYS namespace, for the SP, is to allow access to sensors and other information about system hardware by the SP.

Web Interface

The Web interface to the Sun Fire X4100 and X4200 ILOM Web interface supports both secure (https) and non-secure (http) access. Secure access will be enabled by default. The Web interface provides the same functionality as the CLI. It is divided into five main sections:

- System Information
- System Monitoring
- Configuration
- Remote Controller
- Maintenance

Remote Keyboard, Video, Mouse, and Storage (RKVMS)

Remote Keyboard, Video, Mouse, and Storage (RKVMS) features are accessible through the ILOM Web interface.

Remote video display is accomplished through the JavaRConsole which is a Java™ Web Start application. JavaRConsole is downloaded from ILOM to the management console machine and executed locally. It does not run on the server and therefore does not put overhead on the host. JavaRConsole is used to redirect the BIOS and setup screens as well as all other platform video output. It provides a true remote video console to the management console by handling the input and output to and from virtual devices and the Sun Fire server. 8- and 16-bit video display are supported up to 1024 x 768. JavaRConsole requires the installation of Java Runtime Environment 5.0 on the management console.

The 3 USB ports connected between the ILOM service processor and the AMD-8111 I/O Hub enable the remote keyboard, mouse, and storage components of the RKVMS functionality. The remote devices are presented to the Sun Fire server by JavaRConsole and ILOM as virtualized local devices.

JavaRConsole captures keyboard and mouse input on the management console and directs it to ILOM. ILOM then transmits these keyboard and mouse inputs over the USB ports to the AMD-8111 aI/O Hub and to the Sun Fire server. The Sun Fire server interprets these inputs as originating from local USB devices.

JavaRConsole is also capable of presenting remote bootable storage to ILOM and the Sun Fire server. The remote storage can be either physical storage devices or bootable media image files on the hard drive. Several types of remote storage are supported:

- CD/DVD-ROM
- Floppy
- CD/DVD-ROM image (.iso files)
- Floppy image (.img files)

When the Sun Fire X4100 or X4200 server attempts to access a Virtual Floppy or Virtual CD-ROM as set up in the BIOS, ILOM redirects this access request to the JavaRConsole. JavaRConsole then accesses the virtual disk content from the management console's physical CD/DVD-ROM drive, physical floppy drive, or from a disk image on the hard drive. ILOM virtualizes this remote storage to the Sun Fire server using the USB ports connected to the AMD-8111 I/O Hub. The Virtualized storage is recognized by the Sun Fire server as local USB connected storage and enables remote operating system boot up and installation.

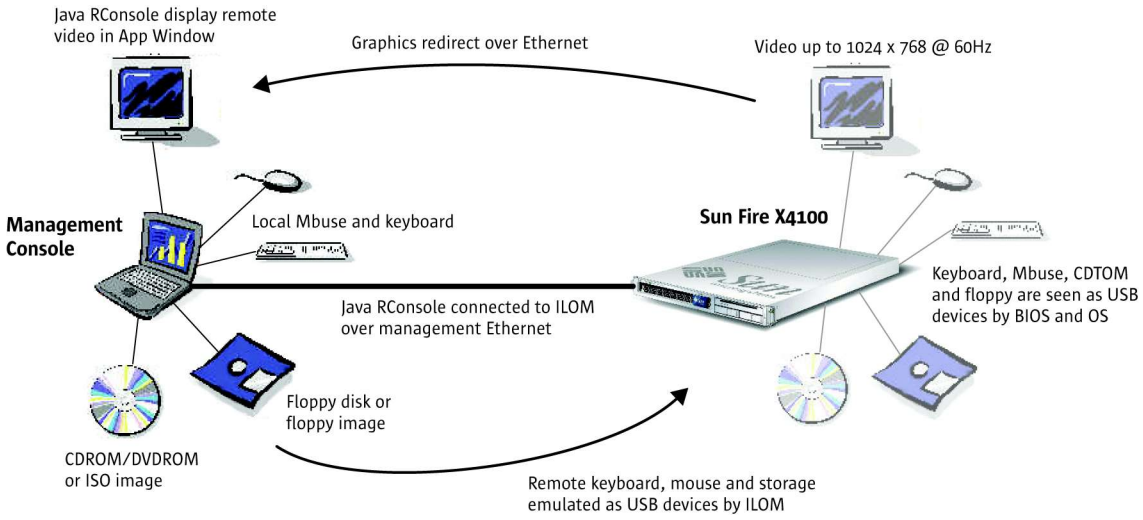
Java RConsole display remote video in App Window
Graphics redirect over Ethernet
Video up to 1024 x 768 @ 60Hz
Management Console
Local Mbuse and keyboard
Sun Fire X4100
Keyboard, Mbuse, CDTOM and floppy are seen as USB devices by BIOS and OS
Java RConsole connected to ILOM over management Ethernet
Floppy disk or floppy image
CDROM/DVDROM or ISO image
Remote keyboard, mouse and storage emulated as USB devices by ILOM

Figure 6-2: Illustration of RKVMS Functionality

Lights Out Management (LOM)

Lights Out Management is performed on the Sun Fire X4100 and X4200 servers through IPMItool, a command-line utility for controlling IPMI-enabled devices.

Intelligent Platform Management Interface (IPMI)

Platform management refers to the autonomous monitoring, logging, recovery, and inventory control features implemented in hardware and firmware. The key differentiator of Intelligent Platform Management is that these functions are independent of the main CPU, BIOS, and OS. There are two major components of platform management: the Service Processor (or BMC) and System Management Software (SMS). Intelligent Platform Management capabilities are a key component in providing enterprise-class management for high-availability systems. Platform status information can be obtained and recovery actions initiated under situations where system management software and normal in-band management mechanisms are unavailable.

The Service Processor is the brain behind platform management and its primary purpose is to provide autonomous sensor monitoring and event logging features. Typical sensor-related events are out-of-range temperature or voltage and fan failure. When an event occurs, it is noted in the system event log and made available to SMS. The Service Processor is powered by the power supply stand-by voltage and will function even when the server is powered down or the operating system has crashed. This allows platform status to be obtained and recovery initiated under situations in which in-band delivery mechanisms are unavailable. In modern systems, the Intelligent Platform Management Interface provides a hardware-level interface specification for monitoring and control functions. It defines a standard,

abstract, message-based interface between the BMC and SMS and a common set of commands for operations such as accessing sensor values, setting thresholds, logging events, and controlling a watchdog timer. IPMI messages can be used to communicate with the BMC over serial and LAN interfaces, so software designed for in-band (local) management can be re-used for out-of-band (remote) management simply by changing the low-level communications layer.

IPMItool

IPMItool is a simple command-line interface to systems that support the IPMI v2.0 specification. IPMItool provides the ability to read the sensor data repository and print sensor values, display the contents of the system event log, print field-replaceable unit information, read and set LAN configuration parameters, and perform remote chassis power control. IPMItool was originally written to take advantage of IPMI-over-LAN interfaces but is also capable of using the system interface as provided by a Linux kernel device driver such as OpenIPMI or a Solaris™ driver called BMC, which is included in Solaris 10. IPMItool is available under a BSD-compatible license. System Management Software is generally complex and makes platform management only part of a much larger management picture. However, many system administrators and developers rely on command-line tools that can be scripted and systems that can be micro-managed. IPMItool takes a different approach to SMS and provides a completely command-line oriented tool. Therefore, it is not designed to replace the OpenIPMI library. Where possible, IPMItool supports printing comma-separated values for output to facilitate parsing by other scripts or programs. It is designed to run quick command-response functions that can be as simple as turning the system on or off or as complex as reading in the sensor data records and extracting and printing detailed sensor information for each record.

SNMP

SNMP management provides remote access by SNMP-compliant entities to monitor and control network devices, and to manage configurations, statistics collection, performance, and security on a network. SNMP is a network management protocol used almost exclusively in TCP/IP networks. The Sun Fire X4100 and X4200 servers provide SNMP MIBs to manage and monitor the servers using any SNMP-capable network management system, such as HP OpenView Network Node Manager (NNM), Tivoli, CA Unicenter, or IBM Director. The MIB data describes the information being managed, reflects current and recent server status, and provides server statistics.

SNMP v1, v2c, and v3 will be supported. v1 and v2c will be disabled by default. v3 will be enabled by default. SNMP sets may be enabled and disabled and will be disabled by default. SNMP traps can be generated from within the SP. An IPMI-specific trap, called a Platform Event Trap, or PET, may also be generated. The following SNMP MIBs are supported:

- The system group and SNMP group from the RFC1213 MIB
- SNMP-FRAMEWORK-MIB
- SNMP-USER-BASED-SM-MIB
- SNMP-MPD-MIB
- ENTITY-MIB

- SUN-PLATFORM-MIB

Sun N1 System Manager

As the number of systems grow in any organization, the complexities of managing this infrastructure through its lifecycle becomes increasingly apparent. A server could see many re-provisions applied to it in its lifetime. Once provisioned, organizations must continuously monitor and manage the infrastructure to ensure that systems are running at desired levels.

Managing each step of the infrastructure lifecycle is challenging for even the most sophisticated IT organizations. Sun N1™ System Manager helps customers address these problems with its new infrastructure lifecycle management software.

Designed specifically to address the problems associated with managing infrastructure throughout its lifecycle, N1 System Manager helps customers provision, monitor, and manage Sun x64 servers. N1 System Manager will expand in breadth of HW coverage over time to encompass current and future Sun systems.

Sun N1 System Manager enables the provisioning, monitoring, patching and management of hundreds of Sun's AMD Opteron based x64 servers. Management tasks are executed through a hybrid UI that integrates the GUI and CLI in one console. The ability to create logical groups of systems and perform actions across a group of systems as easily as performing actions on a single system is possible with N1 System Manager. Additionally, a central console is provided to rapidly deploy Solaris or Red Hat Linux to multiple Sun x64 servers.

The key features of the Sun N1 System Manager software are:

- Bare metal discovery
- Grouping
- Bare metal provisioning
- Hardware monitoring
- OS provisioning

Chapter 7

Software Operating Environment

The Sun Fire X4100 and X4200 servers support multiple 32-bit and 64-bit operating systems, including Solaris, Linux, and Windows. The Sun Fire X4100 and X4200 servers are also VMware ESX Server compatibility certified. Table 7-1 lists the different operating systems supported on the Sun Fire X4100 and X4200 servers.

Table 7-1: Supported Operating Systems

Operating System		Sun Supported
Solaris 10 on x64	64-bit	Yes
Red Hat Enterprise Linux 3.0	32-bit	Yes
Red Hat Enterprise Linux 3.0	64-bit	Yes
Red Hat Enterprise Linux 4.0	64-bit	Yes
SuSE Linux Enterprise Server 9	64-bit	Yes
Microsoft Windows Server 2003	32-bit	Yes
Microsoft Windows Server 2003	64-bit	Yes
VMware ESX Server	32-bit	No – VMware HCL + Support

Solaris 10 on x64, Red Hat Enterprise Linux 3.0, Red Hat Enterprise Linux 4.0, SuSE Linux Enterprise Server 9, and VMware ESX Server operating systems can be ordered from Sun. Support contracts are also available for these operating systems as well as Microsoft Windows Server 2003 Enterprise/Advanced Server Editions 32/64-bit from Sun for the Sun Fire X4100 and X4200 servers.

The Sun Fire X4100 and X4200 servers have been qualified by VMware and are listed on the VMware Hardware Compatibility List which can be seen by visiting the following VMware Web site:
http://www.vmware.com/pdf/esx_systems_guide.pdf

Solaris Operating System Features

Solaris 10 delivers performance advantages for database, Web, and Java technology-based services, as well as massive scalability with price/performance advantages.

- Real-time troubleshooting of system problems
- New tools for low-level system debugging
- System hardware testing and analysis
- Fine-grained project accounting
- Enhanced patch analysis and delivery tools
- Existing applications benefit from Solaris 10 enhancements without modification
- Provides integrated Sun Java™ Enterprise System suite components and the Sun Java Desktop System
- Includes 187 of the most popular free and open source software packages, many of which are supported by Sun
- Provides integrated developer tools such as GNU utilities and Perl and Python programming languages

NOTE: All occurrences of Solaris 10 OS for the Sun Fire X4100 and X4200 servers refer specifically to Solaris 10 for x64 OS, which is the minimum required Solaris release for the Sun Fire X4100 and X4200 servers.

Key Productivity Features

The Solaris Operating System delivers several critical performance and reliability features, such as:

- Enhanced ease of use and PC-interoperability features
- Integrated, high-performance Java technology and tools
- Robust software developer environment
- Advanced, standards-based networking
- Improved systems installation and management tools
- Enterprise-class directory services
- Enhanced desktop tools, I/O standards, and security

Other key features include:

- 100% binary compatibility
- Reliability, availability, and serviceability
- Java 2 SDK
- IPv6/IPsec/Mobile IP
- LDAP directory services
- System management tools
- Desktop management and productivity tools
- Observability
- Internationalization
- Data management
- Real-time application support
- Enhanced security features

Manageability Features

The Solaris 10 Operating System dramatically improves the way system administrators and developers can identify the reasons for suboptimal system and application performance. Solaris Dynamic Tracing (DTrace) technology makes it possible to delve deeply into today's complex systems to troubleshoot problems in real time and quickly eliminate bottlenecks. Additional Solaris 10 features provide enhanced system insight, enabling a system administrator to quickly

identify and resolve hardware problems, and streamline and automate patch management. Solaris Containers can also consolidate multiple applications onto a single system to increase utilization rates and cut system and licensing costs.

Existing applications that adhere to the Solaris x64 OS application binary interface (ABI) and that are compiled with the same APIs, will run unmodified on x64 platforms. In addition, Sun provides an easy-to-use AppCert testing tool for

developers to verify existing Solaris OS application binaries and report any potential incompatibilities.

Interoperability

Understanding that businesses today rely on a mix of technologies from a variety of vendors, Solaris 10 provides tools to enable seamless interoperability with hundreds of heterogeneous hardware and software platforms.

Availability

New Solaris 10 features, such as Predictive Self Healing, offer capabilities that automatically diagnose and recover from hardware and application faults, maximizing system uptime.

Advanced Networking

Support for IPv6 in the Solaris OS is integrated into NFS, RPC, NIS, NIS+, and DNS. IPsec enables secure virtual private networks and network access control. Mobile IP provides Internet disconnect/reconnect capabilities with no data loss.

Bundled Software

Software bundled with the Solaris OS includes Oracle 8i Enterprise Edition, lxrun for Linux application compatibility (for the Solaris OS x64), Apache Web Server, Netscape Communicator, Sun Java System Directory Server, gzip, bash, and tcsh.

The Solaris operating environment ships with a number of software components that increase overall availability, including Solaris Resource Manager software for fine-grained control of system resources, Solaris Bandwidth Manager software for enhanced network resource availability, and Sun Cluster 3.1 software for even greater application availability through a clustered file system, scalable data services, and built-in load balancing.

Sun Studio (90-Day Trial Version)

Sun Studio 10 software is Sun's latest and best developer tool suite for C, C++ and Fortran application development. It continues to provide corporate developers and ISVs with a comprehensive, integrated suite of tools for the development, debugging, tuning, and deployment of enterprise applications on Sun platforms. With this release, Sun Studio 10 software extends its world-class development environment to the AMD64 architecture and delivers reliable, scalable, and high-performance applications for the Solaris 10 Operating System.

Additionally, Sun Studio 10 software provides a common debugger that can visually debug single and multi-threaded C, C++, and Fortran code. It can even handle intermixed Java and native code, an industry first! All of these powerful tools are presented within a NetBeans™-based Integrated Development Environment.

Sun Studio 10 software also provides an integrated development environment (IDE), performance analysis tools and intuitive debugger for Linux operating systems. These components are compatible with GCC 3.2 software. Note that Sun

is not supplying or providing support for the gcc compiler.

Customers using prior software versions including Forte Developer 6 Update 2, Sun ONE Studio 7 Enterprise Edition, Sun Studio 8, and Sun Studio 9 releases can easily upgrade to Sun Studio 10 software since it is fully compatible with these previous releases. The software is full of productivity enhancements, feature improvements, and expanded platform support to make Solaris and Linux application development more productive.

Solaris Flash Software

To improve utilization of the systems that make up today's data centers, administrators are turning to tools such as Solaris Flash software. Solaris Flash software provides new provisioning functionality that allows administrators to capture a snapshot image of a complete system—including the Solaris OS, the applications stack, and the system configuration into a new Flash Archive format. Using this system image, administrators can then rapidly replicate a reference system configuration onto many target systems. Solaris Flash images can be deployed via standard media or over the network via HTTP and NFS protocols. Solaris Flash software images can be installed using custom Solaris JumpStart™ software scripts, the Solaris Web Start software graphical interface, or through interactive installation of the Solaris Operating System.

Solaris LIVE! Upgrade Software

Solaris LIVE!™ Upgrade software allows Solaris OS software to be installed on a separate partition from the currently running version of the operating environment. In particular, Solaris LIVE! Upgrade software enables systems to run uninterrupted while a system administrator installs a Solaris Flash archive or upgrades to a new version of the Solaris Operating System. As a result, downtime for upgrades is reduced to the time needed for a reboot. When installation is complete, a simple reboot enables the Solaris 10 OS to take control. Since Solaris LIVE! Upgrade software includes a version migration and fallback feature, organizations can also fall back to the previous release (again, through a simple reboot) without losing administration information.

Real-Time Video Creation and Broadcast Support

A Java Media Framework (JMF) technology player provides access to the latest industry-standard audio and video files, including MPEG1/2, QuickTime, VIVO, AVI, AIFF, GSM, WAV, RMF, AU, and MIDI.

Solaris 10 OS Bundled Desktop Environments

Common Desktop Environment (CDE) Enhancements

The latest generation of the Common Desktop Environment (CDE) comes standard, providing workstation users with an easy-to-use, open, secure platform. Personal Digital Assistant (PDA) support synchronizes data from most Palm computing devices with the CDE calendar, mail, memo, and address book. CDE now features streaming video using MPEG1, MPEG2, QuickTime, and AVI formats, as well as MIDI audio using Java Media Framework technology.

GNOME 2.0 Desktop Environment

GNOME 2.0, the modern desktop for the Solaris 10 Operating System (OS), provides applications and tools that are designed to enhance business productivity in a networked world. GNOME 2.0 helps organizations achieve their business goals by offering a unified, modern, open, networked, and cost-effective desktop solution. Key features of GNOME 2.0 include:

- Personalization capabilities that allow users to change settings to suit their preferences
- Built-in applications and assistive technology solutions for users with disabilities
- Removes complexity of supporting disparate desktop user environments and provides a richer common unified desktop
- Open file standards provide transparent file and data interchange
- Built-in accessibility support enables all users to interact with the GNOME 2.0 desktop environment running on any UNIX platform
- Flexibility and choice to run GNOME, CDE/Motif, and Java technology-based applications unmodified, preserving existing software investments
- Support for key open standards to facilitate interoperability, compatibility, and collaboration in today's highly-networked, heterogeneous world, including support for XML, DOM, HTTP, HTML, CORBA, MIME, Unicode, MPEG, JPEG, AVI, MIDI, XDnD (drag & drop), X11, NFS, and TCP/IP

GNOME 2.0 for the Solaris OS is open source, free software with no upgrade or licensing fees. More information about GNOME 2.0 is available at http://www.sun.com/gnome.

Solaris OS Licensing and Usage

Under the Free Solaris Binary License Program, Sun is making the binary (runtime) version of its Solaris 10 OS available to anyone who accepts the terms of the Solaris OS Binary Code License (BCL) and the Free Solaris Binary License Program. There are no fees for the right to use the software on computers with a capacity of eight or fewer processors. There is a small charge for the media kit. Refer to http://www.sun.com/software/solaris for current licensing details.

Features of the Solaris OS license include the following:

- No distinction between desktop and server licenses
- Free binary (runtime) license for all systems with eight or fewer CPUs for users who accept the terms of the Solaris 10 OS Binary Code License and the Free Solaris Binary License Program
- Solaris 10 OS software is provided via the Solaris 10 Media Kit available for purchase at http://www.sun.com/solaris/binaries
- Single Solaris Media Kit for installing multiple systems
- Solaris Media Kit contains additional bundled software
- Solaris Supplemental CD of bundled user and system management tools
- Oracle 8i Enterprise Edition (with development license)
- StarOffice™ 7.0 productivity suite
- Solaris Software Companion CD of popular freeware

Chapter 8

Additional Software Included

Sun Installation Assistant

The Sun Installation Assistant software on CD-ROM is included in the ship-kit with every Sun Fire X4100 and X4200 server. Sun Installation Assistant is a Linux installation utility that reduces the complexity of installing supported Linux distributions on new hardware. A newly released platform seldom has a certified set of drivers already in a current Linux distribution. Typically, the result is that an administrator will be required to generate driver disks for each of the supported Linux distributions that they plan to install. Additionally, Linux distributions do not contain support for non-platform drivers such as the Service Processor.

A complete Linux installation on a Sun Fire X4100 or X4200 server can be easily performed using the Sun Installation Assistant CD-ROM either locally or remotely using the remote KVMS features provided by ILOM and the JavaRConsole.

Once the system has been booted from the media or image, a boot kernel is loaded and probes the platform configuration. Upon recognition that the server is a supported platform, a list of the currently supported Linux distributions is displayed and the user is prompted to insert disk 1 of the supported Linux distribution of their choice. Disk 1 can be either a physical CD-ROM disk or a JavaRConsole redirected iso disk image. The Linux distribution installation continues as usual until completion. Following installation completion, the certified platform and device drivers are installed and the complete installation is completed without necessitating cumbersome driver installation procedures. The Sun Installation Assistant manages the software installation of:

- Supported Linux operating systems
- Platform-specific software
- Diagnostic and fault management software
- Add-on components such as the JES middleware stack

Appendix A

Connector Pinouts

USB

Table A-1: USB Pinouts

Pin #	Pin Name	Description
	1+5V	+5V supply
2	Data-	Negative side of differential pair for data
3	Data+	Positive side of differential pair for data
4	Gnd	Ground

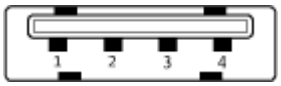

Figure A-1: USB Pinouts

Serial

Table A-2: Serial Pinouts

Pin #	Pin Name	Description
1	CTS	Clear to Send
2	DCD	Data Carrier Detect
3	TXD	Transmit Data
4	GND	Ground
5	GND	Ground
6	RXD	Receive Data
7	DTR	Data Terminal Ready
8	RTS	Ready to Send

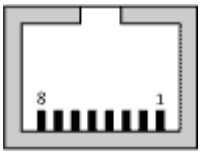

Figure A-2: Serial Pinouts

10/100 BaseT

Table A-3: 10/100 BaseT Pinouts

Pin #	Pin Name	Description
1	TX+	Positive Side of Transmit Data
2	TX-	Negative Side of Transmit Data
3	RX+	Positive Side of Receive Data
4	NC	No Connect
5	NC	No Connect
6	RX-	Negative Side of Receive Data
7	NC	No Connect
8	NC	No Connect

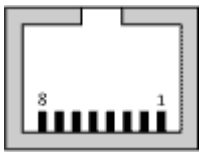

Figure A-3: 10/100 BaseT Pinouts

10/100/1000 BaseT

Table A-4: 10/100/1000 BaseT Pinouts

Pin #	Pin Name	Description
Signal Segment		
S1	GND	2nd mate
S2	TX+	Transmit from PHY to hard drive
S3	TX-	Transmit from PHY to hard drive
S4	GND	2nd mate
S5	RX-	Receive from hard drive to PHY
S6	RX+	Receive from hard drive to PHY
S7	GND	2nd mate
Backside Signal		
S8	GND	2nd mate
S9		
S10		
S11	GND	2nd mate
S12		
S13		
S14	GND	2nd mate
Power Segment		
P1	3.3V	Not supported
P2	3.3V	Not supported
P3	3.3V	Not supported
P4	GND	1st mate
P5	GND	2nd mate
P6	GND	2nd mate
P7	5.0V	Pre-charge, 2nd mate
P8	5.0V	
P9	5.0V	
P10	GND	2nd mate
P11	Reserved	Should be grounded
P12	GND	1st mate
P13	12.0V	Pre-charge, 2nd mate
P14	12.0V	
P15	12.0V	

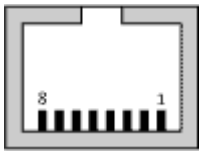

Figure A-4: 10/100/1000 BaseT Pinouts

Serial Attached SCSI (SAS)

Table A-5: Serial Attached SCSI (SAS) Pinouts

Pin #	Pin Name	Description
1	TPO+	Positive Side of Data Pair 0
2	TPO-	Negative Side of Data Pair 0
3	TP1+	Positive Side of Data Pair 1
4	TP2+	Positive Side of Data Pair 2
5	TP2-	Negative Side of Data Pair 2
6	TP1-	Negative Side of Data Pair 1
7	TP3+	Positive Side of Data Pair 3
8	TP3-	Negative Side of Data Pair 3

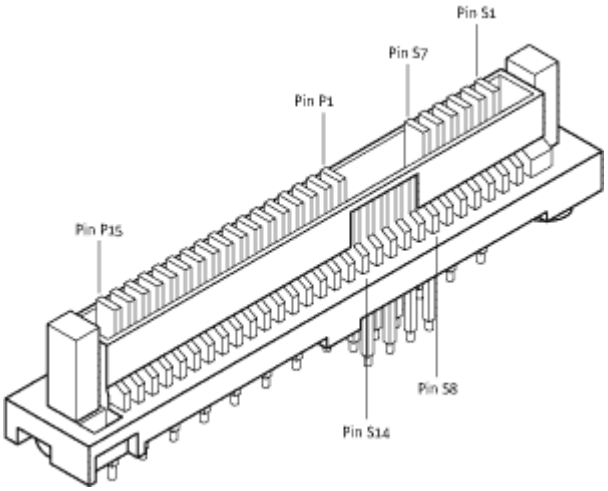

Figure A-5: Serial Attached SCSI (SAS) Pinouts

VGA

Table A-6: VGA Pinouts

Pin #	Pin Name	Description
1	RED	Red Video
2	GRN	Green Video
3	BLU	Blue Video
4	ID2	ID2 (Ground)
5	GND	Ground
6	R_GND	Red Video Return (Ground)
7	G_GND	Green Video Return (Ground)
8	B-GND	Blue Video Return (Ground)
9	KEY	No Pin
10	S_GND	Syn Return (Ground)
11	IDO	IDO (Ground)
12	IDI	IDI (No Connect)
13	HSYNC	Horizontal Sync
14	VSYNC	Vertical Sync
15	ID3/SCL	No Connect

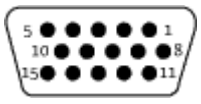

Figure A-6: VGA Pinouts

Appendix B

Sun Fire X4100 and X4200 Rack Mounting Specifications

Sun Fire X4100 and X4200 servers should fit in nearly all 3rd-party racks which meet these criteria:

- Rack has a horizontal opening with unit vertical pitch conforming to ANSI/EIA 310-D-1992 and/or IEC 60927
- Four-post structure (i.e. mounting at both front and rear)
- Distance between front and rear mounting planes is between 610 mm and 915 mm (24 to 36 inches)
- Clearance depth (to front cabinet door) in front of front rack mounting plane is at least 25.4 mm (1 inch)
- Clearance depth (to rear cabinet door) behind front rack mounting plane is at least equal to the cable management arm
- Clearance width (between structural supports, cable troughs, etc.) between front and rear mounting planes is at least 456 mm (18 inches)

To permit installation in racks meeting the above criteria, there is only one rackslide and cable management arm set for the Sun Fire X4100 and X4200 servers. There is no provision in the slide brackets for mounting to non-standard side planes within rack cabinets—all mounting is to front and rear planes only.

For reference, most generic 19-inch format racks of 900 mm or greater overall depth can accommodate the Sun Fire X4100 and X4200; the systems will fit in some shallower racks, and many at 800 mm without the cable management arm.

Appendix C

Sun Fire X4100 and X4200 Server Dimensions

The Sun Fire X4100 and X4200 servers have the following size and weight dimensions.

Table B-1: Sun Fire X4100 and X4200 Server Dimensions

	Sun Fire X4100	**Sun Fire X4200**
Weight	41.1 lbs / 18.6 Kg maximum w/rack kit	52.1 lbs / 23.7 Kg maximum w/rack kit
Height	1.72 in / 43.8 mm	3.44 in / 87.6 mm
Width	17.5 in / 445 mm	17.5 in / 445 mm
Depth	25.2 in / 640 mm	25.2 in / 640 mm

Appendix D

Environmental and Regulatory Compliance

The Sun Fire X4100 and X4200 servers meet or exceed the following environmental and regulatory specifications.

Table C-1: Sun Fire X4100 and X4200 Servers Environmental Specifications

Type	Specification
Operating temperature (single, non-rack system)	10º C to 35º C (41º F to 95º F), 10% to 90% relative humidity, non-condensing, 27º C max wet bulb
Non-operating temperature (single, non-rack system)	-40º C to 65º C (-40º F to 149º F), up to 93% relative humidity, non-condensing, 38º C max wet bulb
Operating altitude (single, non-rack system)	35º C up to 900 meters and a derating of 1 ºC for every 300 m in altitude up to 3048 m maximum
Non-operating altitude (single, non-rack system)	Up to 12000 meters
Acoustic noise (single, non-rack system)	Less than 69 dB sound power in ambient temperature of up to 24º C

Table C-2: Sun Fire X4100 and X4200 Servers Regulatory Specifications

Type	Specification
Safety	IEC60950, UL/CSA60950-01, EN60950, CB Scheme with all country differences
RFI/EMI	FCC Class A, Part 15 47 CFR, EN55022, CISPR 22, EN 300- 386:v1.3.1, ICES-003
Immunity	EN55024, EN 300-386:v1.3.2
Related Certifications: Safety	cULus Mark, TUV GS Mark, CE Mark, CCC, BSMI, GOST R, S-Mark
Related Certifications: EMC	CE Mark (93/68/EEC) Emissions and Immunity, Class A Emissions Levels: FCC, VCCI, BSMI, C-Tick, MIC, GOST, CCC
Other	Labeled per WEEE (Waste Electrical and Electronic Equipment) Directive

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